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University of Alberta

Mathematics Content-Pedagogy Knowledge: A Psychoanalytic and Enactivist Approach

by

Joyce R. Mgombelo Ⓒ

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Department of Secondary Education

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *Mathematics Content–Pedagogy Knowledge: A Psychoanalytic and Enactivist Approach* submitted by **Joyce R. Mgombelo** in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Abstract

This study uses two theoretical frameworks, psychoanalytic and enactivist, to explore the nature of knowledge in teacher education. In particular it explores the nature and growth of knowledge of mathematics student teachers as they undertake teacher education programs and the possibilities or spaces for growth of this knowledge. Attempt is made to go beyond the debates on arguments for or against a prescribed knowledge base in teacher education by pointing to the very kernel of knowledge in teacher education, which the debates neglect.

The data collected consisted of narratives of student teachers, on their teaching experiences, obtained using conversational interview and close observation techniques.

The narratives provide pedagogical space for educators to learn about their practice, through the function of affect and emotions, in enactivist and psychoanalytic perspectives. In psychoanalysis, the narratives delineate the nature of knowledge in teacher education that involves fantasy. This knowledge is performative, and it is central to teaching; it is compelling in the insistence to act and cannot be contained. As well, the narratives have been read in the context of pedagogical relation, highlighting the dynamics of the 'unthinkable' space of pedagogical relation.

To understand knowledge, in teacher education, several ways have been advanced, and knowledge has been given many labels. Central to the approach taken in this study is an attempt to understand these different ways as a reflection of our subjectivity in language and what we human beings call reality.

Our inability to distinguish between what is illusory from what is perceptive is constitutive of our existence as beings in language, as spelled out in enactivism, specifically from Maturana's notion of 'objectivity in parenthesis'. Moreover, from psychoanalysis, what we call reality is based on the disavowal of our fundamental fantasy. Thus, our knowledge includes also our ignorance, with the implication that ignorance is the limit of rather than lack of knowledge. Hence, educators and teachers must learn to include their ignorance in their relation with their students.

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In Memory of:

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Table of Contents

Introduction

MY WAY TO MATHEMATICS EDUCATION

My experience with teacher education began in pre-service education at the University of Dar es Salaam. I was then registered for B.Sc.(Education) in a secondary school route. According to regulations of the university, I was registered in Faculty of Science and I had to study my academic subjects (mathematics and physics) concurrently with my education courses. Education courses by then were offered from the Department of Education. After my graduation at the university, I went to teach at a secondary school. My first appointment was to teach mathematics to Form V (grade 13) students. Although I had taken a mathematics method course at the university, it never occurred to me by then that mathematics pedagogy had anything to do with education. I was a graduate of mathematics; I knew Mathematics; I could teach; and of course I did. I prepared my notes well and I explained mathematics concepts well and students liked me. But when I gave them a test of the course many of them had problems. I wondered why.

My awareness of the relationship of mathematics pedagogy and education started when I won a scholarship for graduate studies (Masters in Mathematics Education) tenable in Canada, at the University of Alberta. During my study at the University of Alberta I was exposed to many ideas in mathematics education and mathematics pedagogy in particular. Principle among these ideas was constructivism — both radical and social. I went back home this time with a new enthusiasm, eager to implement some of the ideas. At the time I had begun to teach a teacher education "methods" course, having secured a faculty appointment with the University of Dar es Salaam. I introduced ideas of constructivism to the student teachers in this course. Observing them in student teaching I noticed that the majority of students did not take up constructivist ideas in their own teaching. Those few who tried found it difficult to bridge their own

students' experiences with the mathematics curriculum as expected in constructivism.

It is within the above personal narrative that I placed my research project. This dissertation is in a large part, a questioning of my own practice. I therefore focused my research in the tradition of action research.

An Orientation Toward Action Research

Action research derives its roots from the work of the German social psychologist Kurt Lewin (Carson, 1992). Lewin was concerned about the gap that existed between theories about society and the dynamics of social practice. Following Lewin various manifestations of action research have developed. In education early work on action research can be traced from the "teacher as researcher" movement (Carson, 1992). The impetus for this movement came from the belief that, by becoming researchers in their classrooms, teachers could improve their practice. This movement has been criticized for its failure to affect institutional attitudes toward research and concentrating on individual action research efforts. This resulted in the academics not taking action research seriously.

Unlike the 'teacher as researcher' movement, my action research is based on the frameworks of psychoanalysis and enactivism. From psychoanalytic perspective, I considered action research as a "master signifier". On one hand, in itself action research as a master signifier does not mean anything, but on the hand it acts as a promise for meaning, or as an anticipation for meaning. Conceived this way action research engaged me and allowed me to stay with the questioning of my practice in a pedagogical way that is central to my study.

My intention for the research was to better understand the nature of knowledge for the teaching of mathematics, in the context of teacher education. In focusing on this intention, I specifically intended to elaborate on the practices of the different strands/perspectives on knowledge in teacher education and identify ways in which mathematics teacher educators can rethink these

practices. The reason for choosing teacher education as a context for my research was twofold. First, I am committed to and involved with both teaching and research in mathematics pedagogy. Second, because teacher education is basically pedagogy of pedagogy, it provides a good site for inquiring about mathematics pedagogy. My work involved several mathematics student teachers in their practicum.

Ethical Considerations

"As a question in which practice, rather than theory, is at stake, the unconscious, in Lacan's view, is grounded not so much in an ontological as in ethical experience" (Felman, 1987, p. 69). In conducting the kind of research I did two things may happen. First it is likely that my conversations with the student teachers might have had different effects on them. Some might have perceived me as someone who possesses knowledge and therefore they might have had false hope and anxiety. Second, this kind of research has transformative effects, both on myself as a researcher and on the other people involved. In the following section I discuss the issues of collaboration and change in action research as a way of addressing the two effects.

Collaboration

Kanu (1997) notes that collaboration has been a problematic aspect of action research between school and university personnel in that roles and responsibilities become difficult to define as both parties have different forms of knowledge and expertise to offer. As I think of my own project I can see the applicability of the above dilemma. How can student teachers, cooperating teachers and I collaborate given our differences? I think the best place to start my discussion on the question of collaboration in action research is on action research projects, which are framed under emancipatory intentions. Kanu's action research project is relevant here.

Kanu (1997) and her project team members were involved in a collaborative action project, which was intended for in-service education of teachers from several developing countries. The project team members had chosen to follow the emancipatory path to action research in order to accord the two parties (the project team members and the teachers) the opportunity to work collaboratively and through reflection, develop understanding for themselves and the issues connected with the project. As is the case with collaboration in action research, members of the project found themselves caught with the question of how they were going to collaborate with the teachers given their differences in expertise. The project team members agreed that collaboration would be interpreted as each party contributing to the task what it was best able to offer. In order to facilitate participation from the teachers' point of view, the project team intended to provide them with as much ownership of the program as possible. And, therefore, although the team had been provided with pre-specified goals around which to design the program, teachers would be allowed to formulate the agenda by coming up with specific issues and problems, which they wanted to be addressed in the program. Following this, the team members resorted to what was considered to be as negotiating the teachers goals for enrolment with the program and the course. This resulted in a new course that included helping teachers re-examine their conceptions in order to develop positive attitudes and dispositions toward teaching.

Just what these members of the project found out from their experiences with the project, given their intentions, is of interest in my discussion. The project team found themselves caught within the kind of dilemma, which Steier (1990) demonstrates below:

> A constructionist researcher is faced with the dilemma of wanting to understand 'how others construct meaning' or 'make happenings' (in their 'language'), while recognizing that he or she is a member of community of researchers who have a particular language with which they demand to be addressed, and that these two languages are not the same. (p.175)

Contrary to what Kanu expected, tensions arose in the project as soon as they started implementing the program. Teachers found it very difficult to question or critique the ideas in the readings or the ideas and observations of the project team members who were also the course tutors. Also, teachers felt insecure when project team members introduced "innovative" instructional strategies based on constructivist philosophy of knowledge and learning such as inquiry teaching and learning, which were intended to foster meaningful and authentic student understanding by allowing students to arrive at their own "truth" through rational inquiry. Kanu (1997) provides some valuable insights about the reasons and ways to resolve these tensions; that is, the teachers were from non-western culture while the program was designed in the west. Kanu's action research raises the more general problem of emancipation. By not questioning the notion of emancipation itself there is a possibility of facing the kind of problem, which Woolgar (1987) suggests below:

> The fundamental problem is that these sociologist- critics are themselves committed to an ideology of representation...So long as they continue to be uncritical about their own use of representation, they will continue to reproduce an impoverished version of what they are fighting for. (p. 326)

Therefore, this problem lies within the emancipation intentions and thus the solution must be found outside these intentions. Gore (1993) demonstrates this by using Foucault's notion of regimes of truth and technologies of the self in analyzing the rhetoric of critical and feminist pedagogy. In the case of emancipatory intentions in action research, Gore provides the following insights:

> Despite the "emancipatory" intentions of those who employ action research as a technique within the social reconstructionist tradition in teacher education, it too, (naturally) functions within regimes of truth. For instance, some theorists, in a clear demonstration of the will to truth declare that unless research is conducted by the entire group of participants in the given social situation affected by the research, it is not worth of the name action research (McTaggart & Singh, 1986). In part this declaration functions to discipline us all into acceptance of a singular

definition of action research, a singular view of truth. It polices the discursive boundaries of action research. (p. 152)

The above observations call for a solution that requires a basic conceptual change about the meaning of collaboration in action research. In fact, if we observe carefully we can see that the dilemma that surrounds the emancipatory intentions in action research, result from embracing the modernist notions of objective knowledge. The emancipatory approaches still embrace Descartes' dictum "I think therefore I am" because what actually happens is that they add to it "I think critically therefore I am" (Bowers, 1993, p. 14). So the only way out would be to abandon the notion of objective reality itself. It is at this point that I turn to the work of Sumara and Davis on complexity theory (Sumara & Davis 1997).

In contrast to the commonsense discourses (including emancipatory approaches) in which teaching and educational research are understood as complicated endeavours that need to be understood by examining their component parts in an objective manner, Sumara and Davis see teaching and educational research as complex phenomena which resist simplistic reductions or interpretations. They see action research as an instance of complexifying the relationship among researchers and research situations so that the boundaries between these are blurred. On the question of collaboration in action research Sumara and Davis observe,

In so doing, we call into question the possibility of some form of "researcher" identity that prefigures involvement in sites of collaborative action research and argue, instead, that the research activities themselves function to generate individual and collective identities. (p. 301)

Thus "action research understood in this way is not a mere set of procedures that enable the interpretation of culture; action research is an instance of 'culture making' in which the various actors are wholly complicit" (Sumara & Davis, 1997, p. 301). It follows that,

... researchers, in particular, cannot think of themselves as "operating in" educational settings, mining the desired data, and then severing all ties.

> Complicity compels us to be attentive to a different sort of investment...it requires a willingness and an effort to formulate one's place in the community (and not letting such participation to go unacknowledged or unformulated) and reciprocally, to allow that community to become part of the research. (p. 309)

I am also reminded here by Jardine's observations from a story told by Ellen (Jardine, 1997). Ellen, a chronic care nurse who for many years had been taking care of stroke patients, decided to do a research as part of graduate work to inform her own practice. She had completed her proposal and was set for her first interview with a stroke victim, a woman whom she had nursed for several years. It did not take long before the woman began to cry in frustration. Ellen was confused. Was she to continue asking questions or to stop and nurse the woman, as had previously been her response? Jardine uses the example to ask us to rethink what we mean by data and lived experience in qualitative research. Like Jardine, Sumara and Davis, also ask us to think about what we mean by action research as living practice.

I envisioned my study as one where the traditional boundaries of research would be questioned, where, I would be able to act responsively. This freed me from the simplistic criticism: that, I have no right to impose my own value judgments on other communities. That is, my role as researcher is to study, rather than to affect, let alone to attempt to transform (Sumara & Davis, 1997).

Change

Ever since its inception action research has been committed to change. Despite the different forms it may take, action research subscribes to the belief that we may simultaneously inform and change ourselves. In fact, it is the action that allows deeper understanding (Carson, 1992). I envisioned my action research project to be as a learning opportunity for myself, student teachers, and others involved; that is, we could emerge from the process with a deeper self-understanding and transformation. However, keeping in the spirit of Foucault's

notion that everything is dangerous (Gore, 1993), these intentions need to be critically analyzed. As was the case with the above discussion on collaboration, the best way is to start with the analysis of those action research projects, which are committed to emancipatory intentions.

Descartes' view of the individual as self-constituting (and thus as free of the influence of the past), as well as the procedural method of thinking that he helped to establish, contributed to the enlightenment belief that rationally directed change puts history on a linear and progressive path (Bowers & Flinders, 1990). Thus, according to Descartes, change is progressive. As argued earlier, despite their critical intentions, action research projects committed to emancipatory approaches continue to embrace Descartes' view. They too view change as progressive. They view rationally empowered individuals as agents of progressive change. This can be seen in the language used in these projects such as the use of consciousness raising and constraints (Tripp, 1990). Using Foucauldian analysis of power-knowledge, Gore (1993) critiques the notion of empowerment in emancipatory action research:

> ..."empowerment" implies (1) a notion of power-as property (to empower is to give confer), (2) an agent of empowerment (someone or something to do the empowerment), and (3) a vision or desired end state (a state of empowerment). (p. 121)

There are dangers in these conceptions of empowerment and change in the emancipatory projects. For Gore, (1993) the dangers come from the fact that emancipatory projects function as regimes of truth.

> These dangers can be seen in a number of ways: in the closure that comes from the, "This is so, is it not? tone which silences other viewpoints; in the limits such assertions place on reflexivity; in what becomes a "strategy of mystification" to which only a select few are given recourse; in the potentially limited impact of the argument, and of discourse in general. (p. 121)

I think the tensions which Kanu (1997) and her project team members experienced with the teacher exemplify these dangers. For example, she reports

the tension where the teachers found it very difficult to question or critique the ideas in the readings or the ideas and observations of the project team members who were also the course tutors. They would rather downplay their own experiences or deny them if they were in discordance with what was read in the handouts.

How are we then to understand change and transformation in action research differently from this modernist conception? Clearly, searching for a new model cannot solve the problem. As Foucault warns, there will always be regimes of truth and technologies of self (Gore, 1993). The point is, then, to continue analyzing them and identifying spaces of freedom and squeeze in them.

Sumara and Davis (1997) using complexity/complicity theory, conceptualize change in the notion of "enlarging the space of the possible". For them,

> ... much of current research, scientific and otherwise, might be interpreted in terms of pursuing the modernist ideal of progress--which, in effect, represents an effort to manage complexity by reducing it to simplexity, to train it to one's purpose, to use it in the project of better controlling ones situation. "Enlarging the space of the possible" is, in many ways, the antithesis of the ideal, arising from insistence that we are collectively moving toward increased complexity and hence, that we are forever falling short of our desire to render the world manageable. (p. 303)

Sumara and Davis see the difference between the desire for progress and the recognition of ever increasing complexity in terms of "simplexity" and "complicity". Simplexity, like modernism, points its desire toward the future; complicity is more focused on the contingencies of the immediate situation, acknowledging that the future is dependent on the present but is not determined by it.

Sumara and Davis' notion of "enlarging the space of the possible" conflates the projects of education and research. "Both involve efforts to deliberately, but thoughtfully, affect the way things are: to enlarge the space of the possible" (Sumara & Davis, 1997, p. 310). It follows from this that "educational research is not merely research that occurs in educational settings,

nor merely that it is focused on educational issues" (p. 309). Rather it must be regarded as research that educates, that makes culture.

This discussion was useful in that it freed me from the modernistic conception of change. I no longer thought of change as progress, as an "object" to be attained outside my actions. It compelled me to think of change as lived practice.

Chapter 1

THE QUESTION OF KNOWLEDGE IN TEACHER EDUCATION

There are indeed among propositions, proposals, problems, questions, those that are decidable, and those that are in principle undecidable. ...Only those questions that are in principle undecidable, we can decide.

Heinz von Foerster, 1991, p. 64

Almost since its inception, teacher education has suffered from doubts about its value to teachers. Outside observers have asked, usually skeptically, whether teacher education makes a difference, while teacher educators themselves have wondered what they have been able to accomplish and how they could accomplish more (Kennedy, 1991). Ideally, one would expect that research on teacher education would help teacher educators better understand whether and how teacher education makes a difference. Yet the question has been difficult to answer. Underlying this question is the problem of knowledge in teacher education. Engaging with the question of knowledge in teacher education raises some fundamental problems. First, there is little agreement in teacher education as to what counts as knowledge and what is the matter with knowledge. Second, the problem of how a person becomes a teacher or how one learns to be a teacher is still an enigma in teacher education. Third, that it is not clear in teacher education as to the role of content or subject matter, more specifically how does one learn to teach a particular subject.

The Nature of Knowledge

There are mainly two orientations as to what is the nature and to what counts as knowledge in teacher education. One justifies the place of teacher education at the university, and calls for a prescribed knowledge base. Another, which challenges the notion of a prescribed knowledge base, argues that this neglects the fundamentally subjective, contextually-based, experiential and personal-

ethical character of teaching practice.

The first orientation is based on a traditional and historical view of teacher education. It has been a commonplace in teacher education to challenge this view by rejecting its assumptions based on its belief on the Cartesian *Cogito*. As Jardine (1998) suggests:

> Descartes took the first steps towards making the earth suffer the tyranny of a subject able to contact anything outside of itself only within the methodical parameters of its own self-presence and self-security. He took the first steps towards, on the one hand, bringing forth the inevitability of the subject as a moment of inquiry (ushering in the age of method as a way of containing the acts of the subject – they must be methodical and reproducible) and, on the other, disconnecting and estranging that subject from life as it is actually lived. (p. 9)

It is from this background that the second orientation of knowledge in teacher education originates. Those who challenge the traditional view of knowledge argue that knowledge does not exist objectively separate from the knowers, their culture, and context. Against this challenge several orientations arise in the field of teacher education and knowledge. These include the narrative inquiry (knowledge is personal and of narrative nature); the phenomenological approach (knowledge is experiential and tacit); the constructivist approach (knowledge is personal and subjectively constructed); the post-structuralism approach (knowledge is constructed from discursive practices); and the situated cognition approach (knowledge is contextually and specific to a particular practice).

Despite this challenge to the traditional nature of knowledge and its assumption, a close look reveals the fact that the influence of Cartesian subjectivity continues to dominate in teacher education and education theory. It continues to dominate not only in the form of those who remain to be for Cartesian subjectivity, but also those who are against the modern Cartesian belief on the self-awareness and self-transparency of the human subject. For as

Jardine (1998) reminds us, we can not return to

> ... what Maurice Merleau-Ponty (1970), called a nostalgia for "our relationship to Being such as they were prior to self-consciousness". Since we owe our idea of and our taste for primordial ontology to just this self-consciousness". (p. 12)

This is a deadlock in teacher education. How are we to return to the Cartesian Cogito without falling into the trap of its manifestation in modern thought (self-transparent and self-awareness subjectivity). The obverse is also true: how are we to locate our critic of the traditional view of knowledge in teacher education and its correlate Cartesian Cogito without falling into the trap of our nostalgia of things as they were before?

The Role of Subject Matter

There is a singular lack of attention to subject matter in the literature on student teachers or beginning teachers. As research in teacher education evidences, teacher educators tend to take teacher's knowledge of the subject for granted and to treat pedagogy in isolation from content (Grossman, 1992; Shulman, 1987). This is surprising especially in secondary school where the work of teachers is defined in terms of subject specialization. Student teachers must master particular subject areas as well as involve themselves in the process of teaching them.

Several factors have been cited to explain the lack of attention to subject matter in the literature on beginning teachers and student teachers. Britzman (1991) notes this as a result of historic separation of knowledge from practice in the university that is centred around liberal arts. This arrangement evidently prevents student teachers from learning about pedagogy and subject matter (academic work) in tandem. This has consequences on teacher education as Britzman (1991) observes,

>While a concept of pedagogy remains potentially powerful, its status is low. Indeed, future teachers and those who work with them perceive coursework in an academic specialization as providing the real credentials for expertise in secondary teaching. Coursework in Education may offer opportunities for acquiring teaching skills, but an academic specialization permits the assumption of particular forms of cultural authority. This is because the academic myth of becoming an expert assumes that knowledge is instructive in and of itself. (p. 38)

Osaki (1990) gives some important observations in the case of Africa, where undergraduate and postgraduate teacher education has received little attention. University faculties of education, that usually coordinate the process, have faced conflicts between the academic content requirements in teacher education on one hand, and the professional components on the other. Some university authorities, especially in the faculties, have been perpetuating academic rationalist arguments to the effect that if a student knows the subject content of science, social science or mathematics they need not dwell at length on teaching and learning processes and classroom techniques. Osaki (1990) also notes that it is not uncommon to hear undergraduate students claim that they are under pressure of time to study and complete assignments in their subject courses. Work on teaching methods is relatively unimportant compared with the major content areas. Yet it is noted from teaching practice reports submitted by student teachers each year at the University of Dar es Salaam, and also from the teaching practice organizer's report, that student teachers face several problems in classroom presentation of the subjects.

Recent research on teacher education also challenges the tendency of teacher educators to take teachers' subject matter knowledge for granted and to treat pedagogy in isolation from content (Grossman, 1990; Shulman, 1986, 1987). Researchers are clarifying what teachers need to know to teach their subjects and exploring how understanding of subject matter interacts with other kinds of knowledge to influence teaching and learning in classrooms (Feiman-Nemser & Parker, 1990).

Responding to the above separation of content knowledge and pedagogy, Shulman (1986) introduced pedagogical content knowledge as a neglected but important way of understanding the knowledge base of teaching. Shulman (1986) defined pedagogical content knowledge as pedagogical knowledge which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching; that is, it is a particular form of content knowledge that embodies the aspects of content most germane to its teachability.

Since Shulman's (1987) articulation of the concept of pedagogical content knowledge, similar challenges of the nature of knowledge in teacher education follow Shulman's idea of pedagogical content knowledge. One, following Shulman, calls for a prescribed pedagogical content knowledge while another argues that this neglects the fundamentally subjective, contextually-based, experiential and personal-ethical character of teaching practice. Sockett (1987), for example, argues that talking about a knowledge base of teaching draws attention away from the fundamentally moral and contextualized character of practice.

Learning to teach

More recently researchers, recognizing the complexity of the teaching profession, have begun generating studies of a naturalistic nature to attempt to capture the evolutional process of professional growth among teachers (Kagan, 1992). Researchers working within this tradition want to learn what students are like when they enter their programs, how they change over time in response to their programs and what they are like when they finish. These studies differ in some aspects. They differ in terms of theoretical or empirical frameworks for conceptualizing teacher change or growth; for example, some use cognitive development models, some use empirical data to conceptualize growth. They also differ in terms of what counts as teacher expertise or good teaching: some emphasize the knowledge demands, others the skill demands, while still others emphasize dispositions, beliefs, orientations, perspectives or values.

Vonk (1995) notes that there are a variety of paradigms ranging from a merely technical interpretation on one end of the continuum, to a purely ecological interpretation at the other end of the continuum. In the technical interpretation, professional development is valued in terms of an increase in research-validated knowledge and skills. Teaching is regarded as an individually centered, culturally neutral, technical action in which language is the main instrument for transmission of knowledge. In the ecological paradigm, professional development is regarded as individual development embedded in social-cultural as well as practical interchanges between the individual teacher and the environment.

The technical perspective can be revealed in the work of Berliner (1988) in which he suggests applying Dreyfus and Dreyfus' theory of developing expertise (derived from artificial intelligence) to developing teachers. Berliner argues that learning to teach should be viewed as an invariant sequence of stages in the accumulation of domain-specific knowledge. Everyone who learns to teach is expected to go through each stage, and later stages cannot be achieved until earlier ones are mastered. According to Berliner, prospective teachers will display the characteristics and experience the needs of the first two of the five stages (novice, advanced beginner, competent, proficient, and expert) during student teaching and the first year or two of full-time teaching. With more experience, more advanced stages will be attained.

From this perspective, teacher education programs should focus attention on preparing the novice. Berliner describes the novice stage as one where the commonplace must be discerned, the elements of the tasks to be performed must be labeled and learned, and a set of context-free rules must be acquired. Thus,

> [i]n learning to teach, the novice is taught the meaning of terms such as 'higher-order questions', 'reinforcement', and 'learning disabled'. Novices are taught context free rules such as 'Give praise for right answers', 'Wait at least three seconds after asking a higher order question'...The novice must be able to identify the context-free elements and rules in order to

> begin to teach. The behavior of ... is very rational, relatively inflexible, and tends to conform to whatever rules and procedure the person was told to follow. Only minimal skill should really be expected. This is a stage for learning the objective facts and features of situations and for gaining experience. (Berliner, 1988, p. 40)

In stage theory, it is argued; student teachers initially concern themselves first with matters of survival and classroom management and then move on to other concerns like how to teach their specific subjects. Kagan (1992), for example, argues that beginning teachers need to focus first on acquiring classroom management and instructional routines before they are able to reflect on more ethical issues or content related dimensions of teaching.

Grossman (1992) identifies three problems with the stage theory model of professional development. First, there is evidence in the literature that student teachers not only concern themselves with the matters of survival and self but also on issues related to the content of teaching. For example, in their studies of the "knowledge growth in a profession" (Grossman & Richert, 1988), pre-service teachers were found wrestling with issues related to teaching of subject matter. Grossman argues that depending on which method is used for collecting data, student teachers are likely to reflect on different concerns. For example student teachers are likely to reflect matters of self in personal journals.

Another problem with the stage theory is that it ignores the impact of teacher education coursework in professional development. Other studies on professional growth among student teachers suggest that teacher education course work can help prospective teachers reflect on issues related to teaching and learning of academic content (Ball, 1989; Grossman, 1990). Furthermore, Kagan's model suggests that managerial routines in classrooms are neutral and non-problematic. Classroom control, Kagan maintains, can be divorced from consideration of teaching and learning. She argues that once teachers establish control they can turn their attention to content and student learning. Grossman (1992) argues that classroom management and instruction are eternally married. How teachers manage classrooms must depend on the ultimate goals of

students. Management is not neutral but carries within its own implicit theories of instruction as well as assumptions about schooling as a form of social control (Britzman, 1986).

In this problem of how students learn how to teach we find the problem of knowledge in teacher education repeating itself. The difficult of comprehending teacher knowledge is combined with the student teachers' uncertainties of becoming a teacher. As Britzman (1991) observes:

> Learning to teach is not a mere matter of applying decontextualized skills or of mirroring predetermined images; it is time when one's past, present and future are set in dynamic tension. (p.8)

The Problem

It follows from the discussion above that the question of knowledge in teacher education is undecidable (von Foerster, 1991). There are difficulties of comprehending the nature of this knowledge, the role of subject matter (nature of knowledge for the teaching of a particular subject) and also the relation of this knowledge with how one learns to teach. This is apparent from the many orientations and descriptions in the literature on teacher education. At the heart of these orientations is the nature of human subjectivity (of what it means to be a teacher or student).

However, being undecidable, the question of knowledge in teacher education is that we can decide. As von Foerster (1991) remarks:

> Why are these questions undecidable in principle? Simply because if they were decidable, a framework must have been chosen within which they are decidable. But since choosing a framework is, in itself, deciding an undecidable question, we can take the decision upon these questions as devices for generating the appropriate framework. (p. 65)

To put in another way: The point is not that we (in teacher education) can never comprehend the nature of knowledge in teacher education; rather the problem is

inherent in the nature of knowledge itself. The problem is not an epistemological obstacle but an ontological one.

This study was conducted from this background. The notion of pedagogical content knowledge as that special amalgam of content and pedagogy has been widely accepted as the starting point for understanding teachers' knowledge for the teaching of a specific subject. The aim of this study was to use this construct to understand the nature of knowledge for the teaching of mathematics and how student teachers learn to teach mathematics.

Cooney (1994) articulates the importance of pedagogical content knowledge in the field of mathematics education. He notes that most mathematics educators are involved in the practice of teacher education at some level. The field of mathematics education is predicated on the assumption that someone has to be educated in order to become the teacher of mathematics. This raises the question of what it means to be educated in order to become a teacher of mathematics.

In addition, my study attempts to move beyond arguments for or against prescribed knowledge, for or against Cartesian subjectivity. I use two frameworks: enactivism and psychoanalysis. These frameworks offer an alternative understanding of human subjectivity and knowledge. Of particular interest is the work on enactivism as articulated by Maturana and Varela and their commentators in various publications (Maturana, 1988, 1991; Maturana & Varela, 1992; Varela, Thompson and Rosch, 1991). Also, of interest is the work on psychoanalysis as articulated by Lacan and his commentators in various publications (Lacan, 1977, 1997, 1998; Zizek, 1989, 1991, 1992, 1993).

The Research Questions

The purpose of the study is to describe and explain the nature and growth of pedagogical content knowledge of mathematics student teachers as they proceed through their teacher education program. Two questions guided the

research: a) what is the nature of pedagogical content knowledge? b) What are the possibilities or spaces for its growth?

Research Methodology

The research questions addressed in this study relate to the experiences of student teachers as they undertake their teacher education program: What is the nature of pedagogical content knowledge of mathematics? And what are the possibilities or spaces for its growth? That is, they address the student teachers' question of what does it mean to 'become a mathematics teacher'. Construed in this way it is the question of identity formation and significance.

In approaching the above question of meaning one could, I suppose, create a list of validated possible changes that occur in a student teacher's move to an experienced teacher. She would then proceed to explore how many of these are experienced by student teacher in various categories such as year of study, economic backgrounds and so on. One might also administer a questionnaire before and after the practicum and compare with the results of student teachers not in the practicum. If we approach the question of meaning by the above methods we will be making an assumption that we have access to objective knowledge. That is we will be isolating our very experiences from the complex web in which they belong. The method shows itself in the question that calls for attention to the consideration of contexts and experiences of student teachers themselves, as well as of the researcher. As I have mentioned in the Introduction of this dissertation, action research as manifested in psychoanalytic and enactivist approaches was used in my exploration of these questions.

In psychoanalytic and enactivist perspectives, cognition is human experience or rather, living. Therefore, psychoanalysis and enactivist inquiries are pedagogical experiences in their very nature. There is thus an intimate connection among psychoanalysis and enactivist inquiry, my research and pedagogy. This has implications. In interpretation, it is not that I apply psychoanalysis and enactivism but rather I am attentive to the implications of

psychoanalysis and enactivism to my research and vice versa. In this way, interpretation is a learning experience.

Data Collection

Data in my study were narratives of student teachers' experiences, their journal records, and notes where applicable. Traditionally, techniques used to obtain this kind of "data" from participants or subjects are by way of interviewing, eliciting written responses, and participant observation. In my research I used similar techniques but with implications from psychoanalysis and enactivism. In what follows I discuss these techniques with implications from psychoanalysis.

Conversational Interview

I used conversational interview to distinguish it from the traditional interview where the researcher's question is addressed to an answer from the other–(the interviewee) which is expected. We learn from Lacan (psychoanalysis) that the true Other is the other who gives the answer one does not expect (Felman, 1987). "Coming from the Other, knowledge is by definition, that which comes as a surprise, that which is constitutively the return of difference" (p. 82). And also that knowledge is not a substance as if contained by any individual but a structural dynamic, that which comes about out of mutual apprenticeship of two partially unconscious speeches (Felman, 1987). Dialogue and hence conversation is the condition of learning and knowledge.

I used conversational interview at first as a means for exploring and gathering an experiential narrative that served a deeper understanding of the research questions. This process attended to those particular or unique situations that arose from student teachers' experiences. Examples of questions were: tell me about your lesson today. What happened? How did this idea first arise? How did you decide on using it in your class? Did you discuss this with other people? Who said what? How did you feel about that?

Secondly, I used conversational interviews to develop a conversational relationship as a partner about the meaning of an experience. This meant going back to the record of transcripts in order to dialogue again with the interviewee. In addition, I used a collaborative conversational interview in which I was comparing notes with other researchers and student teachers where applicable.

Close Observation

I used a close observation technique in the very sense of which van Manen (1990) offers. He distinguishes close observation from experimental or behavioral observation where one uses checklists or schemata to record her observations. He also distinguishes close observation from a simplistic interpretation of participant observation. Close observation requires one to be "a participant and observer at the same time, that one maintain a certain orientation of reflectivity while guarding against the more manipulative and artificial attitude tends to insert in a social situation and relation" (van Manen, 1990, p. 69).

I observed student teachers in their teaching. I kept a journal and gathered events in the form of anecdotes. All conversational interviews were tape-recorded. All data were represented in form of narratives and short anecdotes.

The Research Sites

In my study I used multiple research sites. This not to say that I was looking for repeated events or experiences in the different sites nor used the different sites as categories for characterizing student teachers' experiences. I was interested in the particularity and uniqueness of each site. Each provided an opportunity to explore particular aspects of the research questions.

1. The first site was my own autobiographical recollection of memories and experiences as a student, student teacher, teacher, teacher educator and researcher. In my study, education and research are conflated. Therefore, my

role in the study was not only a researcher but also a learner. It follows from this that my own subjectivity is in play not only in terms of negotiating my identities in my study but also my former identities. I recollected my memories and experiences in the manner of ethics of compassion, from the standpoint of mindfulness/awareness: realizing that it is fundamentally impossible to satisfy desires that are born within the grasping mind (Varela, Thompson & Rosch, 1991).

2. Data drawn from observation of an 8-weeks teaching practicum (Faculty of Education, University of Dar es Salaam). I was particularly interested with this site for two reasons. First, because of my commitment and attachment with the Faculty of Education, University of Dar es Salaam. This site occasioned my reflection on my own practice and experience. Second, as someone who is doing, and has done, graduate work outside my home country (in the West), this site gave me opportunity to question my own knowledge, which I claim to have received.

The Faculty of Education at the University of Dar es Salaam is responsible for the teacher education of mathematics teachers for the secondary schools and teacher colleges. The program encompasses 4 years of study of which 24 weeks are devoted to teaching practice. The teaching practice is spread evenly over the first 3 years of the program (8 weeks each year) and is done at the end of each academic year.

Students enter the program from secondary schools ('A' Level) and teacher colleges (with diploma) and choose their specializations in two teaching subjects. There are basically two routes in the program: the secondary school route and the teacher education route. Students have to choose one of these routes. Students who choose the secondary route teach in secondary school after graduation while those in teacher education route teach at teachers' colleges or adult education centers after graduation. For the case of mathematics, students in the secondary education route specialize in two subjects mathematics and one other subject, usually a science subject. The

Faculty of Science is responsible for the education of these specializations. The students are registered in this faculty and take education courses from the Faculty of Education. Those who choose the teacher education route are registered in the Faculty of Education and specialize in one subject other than teacher education. In the case of student teachers in this study, this one subject becomes mathematics which they receive its study from the Faculty of Science.

Courses offered in the teacher education program include those in educational psychology, educational foundations (philosophy, sociology), which are spread throughout the first, third and fourth years. Others courses include the teaching methods, curriculum development and evaluation, educational media and technology which are offered in the second year and educational administration and independent study which are offered in the fourth year.

There are 45 contact hours allocated for a methods course in mathematics course of which 30 are for lectures and 15 for seminars. Since the methods courses are taken in the second year, the teaching practice at the end of this year is taken to be a special one where their instructors or subject specialists strictly supervise students. The same applies for the third year teaching practice.

In this site I involved mathematics student teachers from all the years involved in the practicum (first, second and third years). I conducted conversational interviews and close observations with four student teachers in this program.

3. A third site involved observation drawn from a 13 week Advanced Professional Term: math student teachers methods course at the University of Alberta. I chose this site, again, because of my attachment to the University of Alberta. More uniquely, this site provided me with the opportunity to participate in the university based methods course. It also allowed me to become introduced with the different aspects of the program such as one-week field experiences, call back, and a peer discussion through the Internet that are not used at the University of Dar es Salaam. I participated in these programs.

I attended some sessions in the methods course so as to closely observe as well as familiarize myself with the student teachers. I also conducted conversational interviews with one student and closely observed her during the practicum. I also collected the peer discussion notes posted by students from the Internet. This was part of an assignment for the methods course. Each student was required to provide at least three postings.

4. A fourth site involved school math classes involved in various research projects. I was invited to participate in a research project aimed at studying the way in which the environment, and student actions and interactions allowed for the occasioning of changing understanding. A class of 28 high school students was involved during a two-month unit of polynomial algebra. I interacted with students, observed students' actions and interviewed the regular classroom teacher on an ongoing basis. This site had a unique influence in my research through participation and conversation with other researchers (Dr. Tom Kieren and Dr. Elaine Simmt) interested in enactivist inquiry. For this reason, this site occasioned my understanding of pedagogical content knowledge from an enactivist perspective.

In this chapter I have outlined the background to the question of knowledge in teacher education. In addition I have described the research approach taken in this study. In the next chapter I present the psychoanalytic and enactivist frameworks as way of understanding knowledge in teacher education.

Chapter 2

PSYCHOANALYTIC AND ENACTIVISM INQUIRY: A WAY OF UNDERSTANDING KNOWLEDGE

In the previous chapter, I introduced the question of knowledge in teacher education. I argued that engaging with this question raises fundamental difficulties in teacher education: of the nature of knowledge itself, of how one learns to become a teacher and of the role of content in teacher education. I also showed that there was little agreement as to the nature of the knowledge itself, on how one learns to become a teacher, and on the nature of the knowledge of teaching a particular subject. I further argued (following von Foerster) that the question of the nature of knowledge in general and pedagogical content knowledge in particular in teacher education was of an 'undecidable' nature. Yet we must decide. What does it mean to decide on this question? As we saw in the previous chapter, this means to approach the question not as an epistemological obstacle to be solved but as ontological question that is inherent to the nature of knowledge itself. This requires approaching the question of mathematics pedagogical content knowledge from the perspective of subjectivity of teachers and students without falling into a debate of 'for' or 'against' prescribed knowledge.

In this chapter I outline ideas of enactivism and psychoanalysis central to an approach that rejects the binary oppositions of subjective/objective knowledge.

My way to Enactivism and Psychoanalysis

My starting point for the decision to use psychoanalytic and enactivism approach is the following observation about other approaches to knowledge in teacher education. Most approaches to the question of knowledge in teacher education, both those that argue for a prescribed knowledge and those that challenge

prescription (e.g., phenomenology, constructivism, narrative inquiry), treat the question as if it were a matter of an epistemological obstacle. In the language of von Foerster they treat the question as if it were a decidable one[1]. By doing so they neglect the very kernel of knowledge in teacher education.

The issue of a prescribed knowledge base in teacher education is an old one. The impetus for this seems to come from the arguments for the place and the status of teaching as a profession. Teaching has been frequently compared positively or negatively to other professions such as medicine and law in terms of the professional body of knowledge that will guide practice. It is argued that the status of teaching as a profession will rise if there is a defined knowledge out of which teaching is based. This movement to professionalize teaching was supported by the earlier movement to professionalize and legitimate the work of teacher education in university settings. Professionalization of teacher education resulted on the emphasis on the faith in the power of the scientific knowledge and study of teaching to provide a basis for building a teacher education curriculum (Zeichner & Liston, 1990). This movement is reflected in the studies and models of teacher education known as "teaching effectiveness" (Anderson & Brophy, 1979).

Despite massive research done in teacher education to support the professional model based on refining the knowledge base for teacher education, many questions continued to arise. More pertinent was the question of how this knowledge was helping student teachers become teachers. Fundamentally there was a problem of how knowledge developed from research would be translated into teaching practice. This was the beginning of a persistent problem of the gap between theory/knowledge and practice in teacher education. The "gap" between what is known about teaching in theoretical and propositional terms and its realization as practice. This realization of the problem of theory-practice gap in teacher education has led to a number of critics of the "teacher effectiveness" model who state that by putting an emphasis on knowledge base it neglects the

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[1] Von Foerster (1991) defines decidable questions as those that are already decided by the choice of the relational framework within which these questions have been posed, together with the rules that connect

practical nature of teaching. Shulman (1987) for example, argued that the narrow focus on teacher effectiveness research neglects important contextual features of teaching such as the subject matter to be taught, the classroom situation, and pupil characteristics. Even though Shulman criticized the reductionist nature of knowledge by the teacher effectiveness researchers, he continued to do the same (in his 1986, 1987 models); that is, putting emphasis on the knowledge base by naming several categories of knowledge[2], including pedagogical content knowledge (which is of interest in my study). The notion of pedagogical content knowledge in mathematics education is discussed in the next chapter.

Apropos of what has come to be known as the traditional approach of knowledge in teacher education and its emphasis on knowledge and neglect of the practical nature of knowledge, a number of approaches to challenge this have sprung up in teacher education and research. While these approaches are centered on a shared emphasis on the practice side of the theory/knowledge-practice gap in teacher education, they differ in what aspect of practice they emphasize. There are those who emphasize the individual teacher as the one who makes decisions about the practice of teaching. Examples of these are approaches of knowledge from the constructivist orientation. It is argued that teachers construct their own knowledge of practice. In mathematics education, this is manifested in "teachers' beliefs" studies. I will discuss these studies in the next chapter. Another example is that of narrative inquiry. Proponents of this orientation see teacher knowledge as being personal, woven in the stories (narratives) teachers tell of their practice (Connelly & Clandinin, 1988).

Other approaches see knowledge from the point of view of the context of the practice. For critical theorists, proponents for a knowledge base in teacher education mistakenly assume a value-free or neutral nature of teaching practice. In reality they argue society's political, social and economic interests pervade teaching practice. Beyer and Zeichner (1987) contend:

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any proposition (e.g., the question), with any other proposition (e.g., the answer) within that framework.
[2] Shulman (1987) classified teacher knowledge in the following categories: subject matter knowledge, pedagogical content knowledge, knowledge of other related content, knowledge of curriculum, knowledge of the learners, knowledge of educational aims and general pedagogical knowledge.

> Every plan for teacher education is necessarily bounded by existing or proposed patterns of schooling and with the social, economic and political contexts in which schooling is embedded…claims to political neutrality in teacher education are illusory and…the process of teacher education is inherently a political and moral endeavor. (p. 312)

A situational cognitivist perspective also emphasizes the notion of context. Situated cognition theory involves the study of individuals in their particular practices. New members of particular practices such as teaching first participate as apprentices acquiring the skills and tools of the practice from the old members (Lave & Wenger, 1991). Proponents of phenomenological approach to teacher education view knowledge in teacher education as intrically related to the teachers' "lived experience" of teaching practice. For van Manen (1991) there is a kind of embodied thoughtfulness in knowing and action, "pedagogical tact" which cannot be learned theoretically or apart from the teachers' lived experiences of working with children in educational situations.

Slightly different from the above orientations are approaches that can be characterized as "Post Tendency" (postmodernism, post-structuralism) to borrow Rotman's (1993, p.15) terminology. Behind all these tendencies is the question of language. The conception of language in this movement can be captured by the slogan "Language speaks man into the world", (Rotman, 1993, p.16). From this slogan, proponents of poststructuralism and postmodernism focus on discourse and identity. Apropos of theory/knowledge–practice gap in teacher education poststructuralists and postmodernists view knowledge as social standpoints and power relationships that produce certain kinds of subjects. The tendency is to learn how teachers or student teachers live their subjectivities in their practices.

It is easy, following Marxist's anti-essentialism, to read the above orientations as an irreducible plurarity (Zizek, 1999) of particular struggles of understanding knowledge in teacher education, depending on particular aspects of teaching practice. To use von Foerster language: tell me what is the nature of

knowledge in teacher education, and I will tell you which aspects of teaching practice you emphasize (narrative inquiry, phenomenology etc.)[3]. What I am suggesting in my study is a different approach, one that looks at the question of theory/knowledge–practice gap not just as an epistemological obstacle to be solved but that which is inherent to the nature of knowledge itself and that which is at the heart of human subjectivity. The question of subjectivity is of course already inherent in the different approaches to knowledge in teacher education. On one hand, the traditional (rationalist) approach has an inherent Cartesian view of the subject, on the other hand the anti-traditional approaches present a challenge to this subjectivity. My approach, which is based on Lacanian psychoanalytic and enactivist inquiries, goes beyond this duality.

In the following section I outline some of the ideas in enactivism (in the work of Maturana, Varela and their commentaries) and psychoanalysis (especially the work of Lacan and his commentaries) that are pertinent to the approach of my study. It should be noted that my presentation of these is not in the sense of a whole theory (be it in terms of summary) but rather as Lacan (1992) points out apropos of his reading of Freud:

> One never goes beyond Freud ... Nor does one attempt to measure his contribution quantitatively, draw up a balance sheet – what's the point of that? One uses him. One moves around within him. One takes one's bearings from the direction he points in. (p. 206)

What I present in the next sections are what I consider to be as central ideas in enactivism and psychoanalysis that point out to the direction of my approach. In addition to this, these ideas are expanded in the way that I use them in my reading, interpretation and construction of my thesis.

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[3] von Foerster (1991) gives an example of the question of the origin of universe: Tell me about the origin of the universe, and I will tell you who you are.

Autopoiesis and Cognition in Enactivism

The starting place of understanding human subjectivity is to begin with life itself, the bio-logic (Varela, 1992a). In their seminal work on biology and cognition Maturana and Varela (1971) introduced the idea of autopoesis to show the organization of a minimal living system. According to Maturana and Varela, autopoiesis (from Greek: self-producing) captures the mechanism or process that generates the identity of a living system and thus distinguishes living things from non-living things. Hence:

> An autopoietic system – the minimum living organization– is one that continuously produces the components that specify it, while at the same time realizing it (the system) as a concrete unity in space and time, which makes the network of production of components possible. (Varela, 1992a, p. 5)

In other words, living things are characterized by an organization in which their only product is themselves (self-producing), with no separation between producer and product.

Autopoiesis addresses a process in which a living system becomes a distinguishable entity. In other words, we can say autopoiesis addresses the "ontology" of a living system. The point is that this is not in terms of the living system's specific molecular composition or its contingent historical configurations. For as long as it exists, autopoietic organization remains invariant. It is an organization, which maintains the very organization itself as invariant.

Another point is the relationship between local components level and the global whole in an autopoietic system. According to Varela (1992a), it is a common place in biology to oppose the traditional mechanistic/reductionists on the one hand and the vitalists/holists on the other hand. This opposition is reproduced in the nature of the relationship between the component elements and the global properties. Both traditionalists and vitalists oppose the local components from the global properties. In contrast, autopoiesis helps us to see

the relationship as a dialectic between the local component levels and global properties linked together reciprocally through the requirements of constitution of an entity that self separates from its background (Varela, 1992a).

What then is the nature of relationship between an autopoietic system and its environment? Here we encounter the paradoxical nature of an autopoietic system. The system must distinguish itself from its environment, and must maintain its coupling with this environment simultaneously. This linkage cannot be detached since it is against this very environment from which the organism arises, comes forth. A very significant observation is that in this coupling between the living system and its environment, the balance is slightly weighted towards the living system; that is, it is the living system, which has the active role in the coupling. "In defining what it is as unity, in the very same movement it defines what remains exterior to it, that is to say its surrounding environment" (Varela, 1992a, p. 7). Varela explains that,

> …this exteriorization can only be understood, so to speak from the "inside": the autopoietic unity *creates a perspective* from which the exterior is one, which cannot be confused with the physical surroundings as they appear to us as observers, the land of physical and chemical laws *simpliciter*, devoid of such perspectivism. (Varela, 1992a, p. 7)

It is as if the environment splits within itself: On one hand, the environment of the living system as it appears to an observer without reference to the autonomous unity. On the other hand, the environment for the system that is defined in the same movement that gave rise to its identity and that only exists in that mutual definition. Following Varela, we might call the environment of the system as simply environment and the environment for the system as its world. "The difference between environment and world is the surplus signification" which is at the heart of understanding cognition and how the "self" becomes one. Here again we encounter another kind of dialectics in the living system between the system's world of significance and the environment. It is not that this surplus of signification is indifferent to the "laws" that operate in the environment but the system's world is built on these laws which is what ensures that it can maintain

its coupling at all times. What the system does is to constantly confront the encounters with its environment and treat them from the perspective, which is not intrinsic to the encounters themselves. We should note here that all this happens not from a sort of agent from outside, but from the constitution of the system itself: with the dialectics between the local processes and the autopoietic unity giving rise to its environment. Put in other words: "the constant bringing forth of signification is what we may describe as a permanent lack in the living: it is constantly bringing forth a signification that is missing, not pre-given or pre-existence" (Varela, 1992a, p. 8). It is this bringing forth of a world of significance (that is missing [or not pre-existing]) which is the cognitive activity of the living system (Maturana & Varela, 1992). It is important to note the paradoxical nature of this cognitive activity. On the one hand, the action that brings forth a world is an attempt to reestablish a coupling with an environment, which defies the internal coherence through encounters. On the other hand, it is such actions that at the same time demarcate and separate the system from that environment, giving rise to a distinct world.

While the above explanations of an autopoietic system applies for minimal or simple living system such as a cell, the same mechanisms can be applied to multicellular organism (including human beings) with nervous systems. What we must note here is the following: while the identity of a multicellular organism is different from a minimal living system, it is similar in that it distinguishes itself as an autonomous unity from its environment. In addition, we must take into account the place of the nervous system and its logic. For Maturana and Varela (1980), the nature of autopoiesis of minimal living thing, allows us to conceive of a basic organization of a cognitive self in terms of operational closure of the nervous system, that is,

> ...the nervous system is organized by the operational closure of a network of reciprocally related modular sub-networks giving rise to ensembles of coherent activity such that:
>
> (i)   they continuously mediate invariant patterns of sensory-motor correlation of the sensory and effector surfaces;

(ii)   give rise to a behavior for the total organism as a mobile unit in space. (Varela, 1992a, p. 10)

Just as is with the minimal living system, the dialectics of the system's world and environment are the same. It follows from the discussion of autopoiesis that living systems involve two kinds of dialects: on one hand we have the dialectics of the identity of the living system, which is established by the dialectics of local components and the global term. That is:

(i)   a *dynamical* term which refers to an assembly of components in network interactions which are capable of emergent properties: metabolic nets, neural assemblies, clonal antibody networks, linguistic recursivity;

(ii)   a *global* term which refers to emerging properties, a totality which conditions (downwardly) the network components: cellular membranes, sensory –motor body in space, self/non-self discrimination, personal "I" (Varela, 1992a, p. 14)

On the other hand, the dialectics of knowledge which is established by the dialects of the system's environment and world. Thus:

(i)   a *significance* term which refers to the necessary emergence of a surplus meaning proper to the perspective of the constituted self: cellular semantics, behavioral perception and action, self and non self as somatic assertion, personal identity,

(ii)   a *coupling* term which refers to the necessary and permanent embeddedness and dependence of the self on its environment, since only through such coupling can its world be brought forth: physical chemical laws for the cellular world, macroscopic physical properties for cognitive behavior, molecular interaction for immune self, socio-linguistic exchanges for our subjective selves. (Varela, 1992a, p. 14)

Language and Being Human in Enactivism

The point made in Maturana's work is that understanding the question of reality can be enhanced if observing and cognition are explained as biological phenomena generated through the operation of the observer as a living human being (Maturana, 1988a).

According to Maturana, we human beings operate as observers; that is, we make distinctions in language. Observing is both the ultimate starting point and the most fundamental question in any attempt to understand any phenomena in the human domain. For Maturana (1988a), "everything said is said by an observer to another observer that could be him - or herself, and the observer is a human being" (p. 27). More importantly,

> a) the observer finds itself in the praxis of living (or the happening of living or the experience) in language, in an experience which as such just happens to him or her out of nowhere; b) any explanation or description of how the praxis of living in language comes to be is operationally secondary to the praxis of living in language, even though the explanation and the description also take place in it; and c) explanations and descriptions do not replace what they explain or describe. (p. 27)

It follows from above that explanations and descriptions are secondary to the praxis of living of the observer (human praxis of living). To put in another way, explanations and descriptions are unnecessary for the praxis of living. This is so even if the praxis of living of the observer changes after his or her listening to them (Maturana, 1988a). These different positions of human being in language; that of praxis of living or being and that of our explanations or descriptions, is also articulated by Lacan. For Lacan, the subject of enunciation and subject of statement are different. The subject is therefore divided. I discuss Lacan's notion of a divided subject and its consequences later in this chapter.

Here we find a very interesting paradox in Maturana's explanation of human cognition and action. As human beings or observers language is both our possibility and our constraint. Since explanations and descriptions are secondary

to our praxis of living in language, it implies that we cannot know the conditions of our being in language. This means that in some ways language constrains us from knowing our being. At the same time, language is our possibility because it is only that we cannot know the conditions for our being in language, we can act: make explanations and descriptions that change our praxis of living. It follows from this that both ignorance and knowledge are part and parcel of human cognition and action. Human action involves some kind of ignorance. It is precisely that I am ignorant of the conditions for my being that I act.

This paradoxical nature of human beings and language is what Varela (1984) calls basic circularity, or the creative circle. For Varela, basic circularity is at the center of understanding natural systems including human phenomena.

To take further this issue let us reflect on Maturana's notion of an explanation. It is the observer who determines whether or not a statement is an explanation. The observer rejects or accepts a statement as a reformulation of a particular situation of his or her praxis of living. If s/he accepts, then the statement becomes an explanation. The observer accepts or rejects a reformulation of his or her praxis of living according to whether or not it satisfies an implicit or explicit criterion of acceptability that he or she applies through his or her manner of listening (Maturana, 1991).

> Regardless of whether we are aware of this or not, we observers never listen in a vacuum, we always apply some particular criterion of acceptability to whatever we hear (see, touch, smell...or think), accepting or rejecting it according to whether or not it satisfies such criteria in our listening. (p. 32)

Maturana (1988a) articulates two fundamental kinds of manners of listening for explanations that an observer may adopt according to whether he or she asks or does not ask for a biological explanation of his or her cognitive abilities. These two kinds of manners of listening define two primary exclusive explanatory paths: path of objectivity-without-parenthesis or the path of transcendental objectivity, and path of objectivity-in-parenthesis, or the path of constituted objectivity.

In the path of objectivity-without-parenthesis, the observer explicitly or implicitly accepts his or her cognitive abilities, as such as his or her constitutive properties. S/he does so by not accepting or by rejecting a complete inquiry into their biological origin (Maturana, 1988a). In this path, the observer listens to a criterion of acceptability that involves a reference to some entity (e.g., matter) that exists independently of what he or she does. It follows from above that this explanatory path is constitutively blind (or deaf) to the participation of the observer in the constitution of what he or she accepts as an explanation. In the path of objectivity-in-parenthesis,

> the observer explicitly accepts a) he or she is as a human being, a living system; b) his or her cognitive abilities as an observer are biological phenomena because they are altered when his or her biology is altered; c) if he or she wants to explain his or her cognitive abilities as an observer he or she must do so showing how they arise as biological phenomena in his or her realization as a living system. (p. 29)

The two explanatory paths have consequences in the explanation of the relationship between human beings/observers and language. For Maturana "we human beings happen in language and we happen in language as the kind of living systems we are" (Maturana, 1988a, p. 43). An observer in an explanatory path of objectivity-without-parenthesis sees language as a system of behavior that observers use to communicate with each other about entities that exist independently of what they do. It follows from this that one cannot avoid the implicit assumption that we have constitutive ability to grasp the existence and features of such independent entities and of symbolizing both their existence and features with words. This means that in this explanatory path words are symbols that stand for independent entities about which we communicate with each other.

In the explanatory path of objectivity-in-parenthesis, one recognizes that the observer is a living system, and that all his or her properties result from his or her operation as such and all the properties of the observer as an observer require a biological explanation. It follows from this that language is a biological phenomenon because it results from the operations of human beings as living

systems. Also language as a domain of recursive consensual co-ordinations of actions does not operate with symbols, yet symbols arise in language as distinctions of relations of distinctions. Words are not symbolic entities, nor do they connote or denote independent objects.

The articulation of language in the two explanatory paths can be explained in what von Foerster (1991) calls the two antagonistic tracks in which language runs: its appearance (objectivity-without-parenthesis) and its function (objectivity-in-parenthesis). "In its appearance, language seems to be denotative, monologuing about things in a world 'out there'; in its dialogic function, however, it is connotative, appealing to concepts in the other's mind" (p. 66).

It should be noted that for Maturana, the decision to follow one explanatory path or another does not depend on rational argument; it depends on one's preference or inner dispositions. Another crucial point not to be missed is the place of emotions in Maturana's scheme. According to Maturana (1988a), emotions are body dispositions for actions that specify at any moment the domain of actions in which the organism move. Maturana explains the relationship of language and emotions or emotioning as follows:

> …languaging flows in the cor-ordinations of actions of human beings in a background of emotioning that constitutes the operational possibility of its occurrence, and specifies at any instant the consensual domains in which it takes place. Still in other words, the operational coherences of languaging have the universality of the operational coherences of the cor-ordinations of actions of the observers in the praxis of living, and the flow of changing emotion under which languaging occurs does not change this, it only changes the domain of actions in which languaging takes place. (p. 49)

Subjectivity in Psychoanalysis

For Lacan there is no subject prior to language. Sarup (1989) summarizes the importance of language in Lacan's theory:

Lacan's theory cannot be presented coherently without a discussion of the function of language. He has a complete theory of language, which he links with subjectivity. He believes that there could not be a human subject without language but that the subject cannot be reduced to language. This is a circular (and not a reciprocal) relationship in which language has privilege. (p. 12)

Lacan introduces the concept of subjectivity not reduced to individuality. That is, the Lacanian subject is not the "subject of signified, the active agent, the bearer of some signification trying to express himself in the language" (Zizek, 1989, p. 160). In opposition to post-structuralists who in reality eliminate the locus of the subject by reducing it to a set of subject positions, Lacan does introduce something. In other words, while Lacan rejects the modernist notion of the Cartesian subject, the self-transparent thinking subject, he however retains the Cartesian subject by bringing into light its obverse forgotten kernel (the unconscious).

The relationship of the Lacanian subject and language depends on specific understanding of language (Symbolic order or Big Other) as the register of signifier. This understanding resulted from Lacan's re-articulation of the Saussurean idea of language as a formal system, which is constructed on the basis of pure difference (Stavrakakis, 1999). Saussure visualized sign as a relation of two parts: the signifier (the sound pattern) and the signified (the concept). In addition Saussure articulated this relation as arbitrary and not natural. According to Saussure, the differential relationship of language applies when, the order of signifier and signified is viewed independently. Viewed together they produce something, which is positive, a sign. This notion of a positive relationship and the arbitrariness of sign in language contradicted Saussure's notion of language as a formal system. In brief, it seemed to evoke the notion of substance as well as representationalist conception of signification, notions that Saussure himself wanted to avoid.

It is from this background that Lacan formulates his notion of language as a register of signifier. To avoid the above problems in Saussurean conception of language, Lacan does the following.

> He subverts the relation between the signifier and signified. Instead of the unity between the signifier and the signified, Lacan stresses their division; if unity prioritizes the signified, division gives priority to the signifier over the production of the signified, a production which only now becomes fully elucidated. (Stavrakakis, 1999, p. 24)

In his scheme, Lacan represents the relation between the signifier, S and the signified, s as S/s, signifier 'over' signified. This 'over' corresponds to the bar separating them, the barrier resisting signification. For Lacan then meaning is produced by the differential relationship of the order of signifier. In order to illustrate this idea Lacan (1977) gives an example of two identical doors leading to two identical toilets, with labels 'Ladies' and 'Gentlemen'. What creates the different meaning between the ladies' toilet and the gentlemen's toilet are the different signifiers, 'ladies' and 'gentlemen'. The point not to be missed here is that it is the notion of signified as a concept in Saussurean way that disappears in Lacanian theory. However, Lacan retains the signified as a structural position, as that which is lost/impossible, designated by a constitutive lack. Put in other words what is retained is the promise or aspiration of attaining this signified to fill in the lack. That is, signification is articulated around the illusion of attaining this signified which is an effect created by a signifier in the process of signification.

It is precisely in the articulation of language as the register of the signifier, that Lacan articulates the subject as the subject of the signifier, the subject of lack, divided. The subject, tries to articulate himself (or to identify) himself in language (symbolic order) in a signifying representation, the representation fails. This is because meaning is differential between signifiers, which implies there is no signifier that can represent the subject; that is, the subject cannot find the signifier that would be his own. It is this impossibility/lack to find the signifier that will be his own which is the subject. The only signifier that the subject identifies with is that which represents him for another signifier. This signifier, which the

subject identifies with, is his symbolic identification (e.g. teacher, father). As we have seen this signification or representation creates an illusion of attaining the signified. This feature refers to the subject's imaginary identification and the ego. This imaginary identification is what gives the subject its illusion of the self as an autonomous agent, which is present in the beginning as the origin of its acts. It is the way for the subject to misrecognize his dependence on symbolic order. He is the observer in objectivity without parenthesis in the Maturanian sense.

In short the subject can be understood in three distinct moments. First, the real "presence that is speaking to you," the speaking body, the subject of the actual act of enunciation. Second, is the symbolic subject indicated by the *I* (*je*) of the speaking body's discourse, the subject of the statement actually uttered. The third moment of the subject, distinct from both the speaking body and *I*, is the imaginary "ego" (*moi*), constructed early in childhood to give the subject an identity that it really lacks. Since the *I* as the subject of speech is located in the symbolic order the domain of language and culture, it can never be exactly the self of being that is, the subject is divided.

We are now able to understand the meaning of '*decentrement*' or/and alienation of the subject. As Zizek (1997) observes:

> '*Decentrement*' thus first designates the ambiguity, the oscillation between symbolic and imaginary identification – the undecidability as to where my true point is, in my 'real' self or in my external mask, with the possible implication that my symbolic mask can be 'more true' than what it conceals, the 'true face' behind it. At a more radical level, it points towards the fact that the very sliding from one identification to another, or among 'multiple selves' presupposes the gap between identification as such and a void of $ (the 'barred subject') which identifies itself – serves as the empty medium of identification. In other words, the very process of shifting among multiple identifications presupposes a kind of empty band, which makes the leap from one identity to another possible, and this empty band is subject itself. (p. 141)

Human existence, which is existence in language, involves the kind of "forced choice". In order to exist in a symbolic order one has to accept a fundamental alienation or decentrement. Paradoxically it is this forced choice that gives us freedom, freedom to symbolize (to pursue our identities) in order to constitute ourselves as such. Put in other words, it is the failure of representation of a subject, the impossibility of subject of the signified that paradoxically makes possible the process of identification itself, the sliding from one identity to another.

The process of identification never results in the "absence of a remainder" (Zizek, 1989). The failure of representation of the subject, or the impossibility of the subject of signified, opens a gap in the symbolic order. Here, Lacan's theory comes close to Maturana and Varela's theory of autopoiesis. This gap opened in the symbolic order is similar to the autopoietic system's world discussed above. In this way one can say the Lacanian subject is an autopoietic system. Just as the difference between the autopoietic system's world and environment is that of surplus signification, this gap too in the symbolic order is that of surplus signification, the excess, which is the subject itself. The crucial point not to be missed is not only that the subject is divided or barred but also that the symbolic order, the Big Other, is lacking or barred.

The gap opened in the symbolic order is crucial for understanding Lacan's theory of subjectivity. At this gap opened by the subject in the symbolic order, Lacan locates the impossible *jouissance* (real kernel of enjoyment). Thus:

> Jouissance is thus the 'place' of the subject – one is tempted to say: his 'impossible' Being-there, *Da-Sein*; and, for that very reason, the subject is always-already displaced, out-of-joint, with regard to it. Therein lies the primordial '*decentrement*' of the Lacanian subject: much more radical and elementary than the *decentrement* of the subject with regard to the 'big Other', the symbolic order which is the external place of the subject's truth, is the decentrement with regard to the traumatic Thing-joiussance which the subject can never 'subjectivize', assume, integrate. (Zizek, 1997, p. 49)

This means that the symbolic order cannot give the subject the guarantee of meaning. Put differently, the symbolic order becomes inconsistent when *jouissance* is allowed. It is structured around the impossible real kernel of *jouissance*, around a central lack. This prohibition of *jouissance* is very crucial to understanding the notions of desire, fantasy, *objet petit a* (object-cause of desire) and drive in Lacan's theory.

According to Lacan, "desire is inherently in the way we are constituted as divided subjects" (Carson, 1997, p. 80). Desire arises as a consequence of the subject subjected to the symbolic order or to the order of signifier, as such desire is the desire to capture the subject's being (signified) which is barred by the signifier. Because of this, desire is never satisfied. For Lacan,

> ...human desire (in contrast to animal instinct) is always, constitutively, mediated to a reference to Nothingness: the true object-cause of desire (as opposed to the objects that satisfy our needs) is by definition, the metonymy of lack a stand in for Nothingness. (Zizek, 1999, p. 107)

This object-cause of desire is what Lacan calls *objet petit a*. The *objet petit a* is that part of the subject's being which is simultaneously left out and produced by the signifying process. It is an attempt to fill out the gap or the lack; as such it is the metonymy of lack.

The point to be noticed here is the way desire arises: when we perform what Zizek (1997) calls 'anamorphic shift of perspective': "what we misperceived as the obstacle (the prohibition), the condition of impossibility, is actually a positive condition of possibility (of our desiring)" (p.77). In this way inasmuch as *jouissance* (enjoyment) is prohibited by the symbolic order, desire arises as desire for this impossible *jouissance*. This is the paradoxical performative power of the symbolic order: by prohibiting what is already impossible through its laws, it makes us believe that it is possible, and makes us desire it. Another thing to be noticed is that, since *jouissance* is impossible for the symbolic order (Other) as well, we can say that the Other also desires. Hence the famous Lacan dictum: "desire is the desire of the Other". Put differently, desire desires itself.

The function of fantasy in Lacanian subjectivity can be understood in relation to the lack in the symbolic order. Fantasy appears as an answer to the inconsistent Other when penetrated by *jouissance*. Fantasy constitutes "the frame through which we experience the world as consistent and meaningful – the a priori space within which the particular effects of signification take place" (Zizek, 1989, p. 123). In this way fantasy functions as a support for desire.

The notion of drive in Lacan's scheme can be explained in relation/contrast with desire. We recall that desire attempts to deal with the impossible *jouissance* prohibited by the order of signifier. In contrast to this drive is indifferent to *jouissance*. Drive "emerges as a kind of 'necessary by-product' of instinctual body getting caught in the web of the symbolic order" (Zizek, 1999, p. 296). Desire cannot be satisfied. It moves from one object to another; drive always finds satisfaction. In other words, drive is penetrated with *jouissance*. However, the *jouissance* associated with drive is the painful (perverted) *jouissance (pleasure in pain)* because in strict sense *jouissance* is impossible.

The notion of the lack or gap in the symbolic order also allows us to explain the notion of the Real. We recall that the subject who is a lack too opens this gap in the symbolic order. In this sense we can say the gap is an overlap of two lacks. The Lacanian Real is this irreducible gap, which is an overlap of the two lacks. It constitutes a space of 'logical' (possible) gains and losses. Zizek (1989) explains this nature of the Real as follows:

> We have the Real as the starting point, the basis, the foundation of the process of symbolization …, the real which in essence *precedes* the symbolic order and is subsequently structured by it when it gets caught in its network: this is the great Lacanian motif of symbolization as a process which mortifies, drains off the fullness of the Real of the living body. But the Real is at the same time the product, the remainder, leftover, … the excess, which escapes symbolization and is as such produced by the symbolization itself. In Hegelian terms, the real is simultaneously *presupposed* and *posed* by the symbolic. In so far as the kernel of the Real is *jouissance*, this duality takes the form of a difference between

jouissance, enjoyment and *plus-de-jouir*, the surplus enjoying: *jouissance* is the basis upon which symbolization works, the basis emptied, disembodied, structured, by the symbolization, but this process produces at the same time a residue, a leftover, which is the surplus-enjoying.

The Real is the fullness of the inert presence, positivity; nothing is lacking in the Real - that is, the lack is introduced only by the symbolization; it is a signifier, which introduces a void, an absence in the Real. But at the same time the Real is in itself a hole, a gap, an opening in the middle of the symbolic order – it the lack around which the symbolic order is structured. (p.169-70)

This then is the nature of the Lacanian Real: basic circularity, recursive.

Implications

A close look at the nature of research on knowledge in teacher education indicates the persistence of the gap between knowledge and practice. Far from interpreting this persistence as a limitation, I suggest approaching the gap as inherent in the nature of knowledge in teacher education itself. In their discussion on the relationship between psychoanalysis and cognitive neurosciences, Cohen and Varela (2000) come close to what I am suggesting in my approach when they contend: "As Enlightenment thinkers, we separate, purify and oppose for the sake of clarity. What if we take a different path and mix, contaminate and merge for the sake of complexity?" (p. 2)

What if instead of approaching the question of knowledge in teacher education as either that of theory/knowledge base building or practice, we mix, contaminate, and merge them? The answer to this question evokes the notion of complementarity or a middle way relationship of knowledge/theory and practice in teacher education. Complementarity can be viewed in two ways. One, in which the two sides are viewed as complementing each other, the other in which the two sides are mutually exclusive as in the relationship of a figure and its background (Zizek, 1996). It is the second way that is at the heart of enactivism

and psychoanalytic theories. For Varela, Thompson and Rosch (1991), enactivism is middle path between "the Scylla of cognition as the recovery of a pre-given outer world (realism) and the Charybdis of cognition as the projection of a pre-given inner world (idealism)" (p. 172). This as Cohen and Varela (2000) suggest leads us to the notion of quasi-object(s) or subjects. The quasi-objects or subjects which are

> …always already in place in the unthinkable space between the two poles of nature/subject – society dualism. They are in fact, the inexorable effect of this very dualism. It is therefore not a question of forging, but one of developing the capacity to recognize and interpret these elusive, undecidable, chimerical monsters, and then cultivating the working spaces to keep them in full view. (p. 2)

Examples of these quasi-objects or subjects are the Real, and *objet petit a* in Lacanian theory. What is crucial to understand here is the function of these quasi-objects and subjects:

> …if our experience of reality is to maintain its consistency, the positive field of reality has to be 'sutured' with a supplement which the subject (mis)perceives as a positive entity, but effectively a 'negative magnitude'. (Zizek, 1997, p. 81)

The nature of the relationship of the two terms of these 'unthinkable spaces', the "two terms of a choice do not form a Whole, (of a figure and its ground) since each choice already constitutes its own Whole which excludes its opposite" (Zizek, 1996, p. 211). This is what constitutes human subjectivity in enactivist and psychoanalytic perspectives. As a human being in language the subject is 'forced' to choose a certain fundamental loss or impossibility: the loss of being (signified), the impossible *jouissance*, and to accept our experience in language as coming from nowhere etc. But it is precisely through this choice that the subject is free to symbolize, explain etc. This complementarity is the basic circularity as suggested by Varela (1984).

Perhaps the starting point for looking at subjectivity in teacher education is to view it in terms what van Manen (1994) and Spiecker (1984) call "pedagogical

relation". As with the question of knowledge/theory and practice in teacher education, the notion of pedagogical relation has been debatable in teacher education. Rather than repeating the review of debates on pedagogical relation, I am suggesting that pedagogical relation be viewed as the "unthinkable space" as discussed by Cohen and Valera (2000). This way we are able to evoke those quasi-objects and subjects in this space, which is at stake in teacher education. In the next chapter I attempt to use the approach described above to read the different perspectives on knowledge in mathematics teacher education.

Chapter 3

TEACHERS' KNOWLEDGE IN MATHEMATICS EDUCATION

In this chapter I discuss different perspectives on knowledge in mathematics teacher education. It should be noted that most mathematics educators are involved in the practice of teacher education at some level. Certainly results from research in mathematics pedagogy and mathematical understanding are predicated on the assumption that teachers and teacher educators will learn or benefit from them. Since my interest is on the nature of knowledge and its growth in teacher education I have selected those studies that deal with mathematics teaching.

There are various perspectives on the nature of knowledge of teaching mathematics in mathematics teacher education. Examples of these are constructivism (e.g., radical, social), social cultural (e.g., situated cognition) and poststructuralist. My aim in this chapter is not to present a critique of the various perspectives in the traditional sense, but to provide a psychoanalytic and enactivist reading of some of the perspectives with a view of learning from them. To this end, I have selected two major strands in the perspectives in mathematics teacher education. These are the technical and cognitive perspectives. In each strand I have selected a few studies. My interest is on those studies that deal directly with teacher education.

The Technical Perspective

In this perspective, the notion of pedagogical content knowledge follows from the work of Shulman (1987). For him, pedagogical content knowledge represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, and represented for instruction. Wilson, Shulman and Richert (1987) outline the teaching process that is involved in the blending of pedagogy and content: teaching is portrayed as a cyclic process;

beginning with comprehension of the content taught, followed by the transformation of the content into a form that makes it accessible to students, then instruction, evaluation, and reflection, leading to new comprehension and another teaching cycle at a higher level of understanding and performance.

Shulman (1987) notes that, saying that a teacher must first comprehend both content and purposes does not particularly distinguish a teacher from non-teaching peers. Accordingly, the key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy. It lies in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variation in ability and background presented by the students.

In addressing the question of pedagogical content knowledge in mathematics education, Anderson (1989) notes two important questions for educators of prospective teachers. What exactly do prospective teachers need to know about their disciplines, and how will they use that knowledge? Anderson notes that, Shulman, Wilson and Richert answer the "how" but they are less helpful in answering the "what" question. What is the nature of the disciplinary knowledge that teachers need to successfully carry out this transformation process?

Anderson identifies three aspects of disciplinary knowledge needed for good teaching: structure, functions and development. The structure of knowledge in a discipline refers to relationships among the facts, concepts and procedures, of a discipline. What are the important themes and how do they tie the details together? How are the ideas from one branch of the discipline related to ideas from another? For example, problems involving the area of figures can be represented and solved in a variety of ways, including figures with squares drawn on them, multiplication of numbers representing length and width, graphs, or algebraic formulas.

The functions or purposes of knowledge in a discipline are the activities that knowledge of the discipline prepares people to accomplish. What can we do with our disciplinary knowledge that is personally satisfying or socially useful?

The development of knowledge in a discipline can be analyzed either historically or as it occurs in individual learners.

What happens when this approach to pedagogical content knowledge is applied to preservice education?

The Technical Perspective and Teacher Education

Eisenhart, Borko, Underhill, Brown, Jones, and Agard (1993) study is a good example for understanding how student teachers learn to teach from the technical perspective on pedagogical content knowledge. Eisenhart et al. report a study in which they explored one student teacher's ideas and practices of teaching for procedural and conceptual knowledge. According to Eisenhart et al., "procedural knowledge refers to mastery of computational skills and knowledge of procedures for identifying mathematical components, algorithms, and definitions (knowing how to identify a problem, in its broadest and most routine sense, and how to solve it correctly)" (p. 9). Conceptual knowledge refers "to knowledge of the underlying structure of mathematics – the relationships and interconnections of ideas that explain and give meaning to mathematics procedure" (p. 9).

Eisenhart et al. do not state explicitly what they believe to be mathematics pedagogical content knowledge. From their paper they seem to indicate that mathematics pedagogical content knowledge is the representation of conceptual knowledge and its underpinnings of mathematical procedures, as they describe their observation on one of occasions:

> With respect to pedagogical content knowledge, the interviews revealed that Ms. Daniels considered concrete and visual representations to be important for conceptual learning. … The success of her attempts to teach for conceptual knowledge seemed to be directly related to the power of those representations (e.g. their ability to the make the content comprehensible, their appropriates to the abilities and interest of learners; Shulman, 1987). A good example is her introduction of volume to the

rectangle…Ms. Daniels began the introduction by comparing volume to surface area, explaining that surface area is "the distance around the outside of a three dimensional figure." Volume is "the space inside of … a box, a rectangular prism." She then showed the pupils an empty cardboard box, which they identified as a rectangular prism. She explained, "[It's a] rectangular prism. And it just so happens that this rectangular prism is filled with cubes or cubic units." (Eisenhart et al., 1993, p. 21)

According to Eisenhart et al. although this was one of the student teacher's successes in terms of pedagogical content knowledge, she also experienced some difficulties on many occasions. There were tensions in the student teacher: between her desire to teach for both conceptual and procedural knowledge, on the one hand and pressures exerted on or by her, many of whom supported procedural teaching, on the other hand. In general this student teacher taught more consistently for procedural knowledge. Let us move to a psychoanalytic and enactivist reading of the technical perspective.

Psychoanalytic and Enactivist Reading of the Technical Perspective

Much has been said criticizing the technical perspective of pedagogical content knowledge. Critics argue that the emphasis on knowledge (pedagogical content knowledge) by this perspective reinforces the absolutist and decontextualized view of mathematics. In addition, the technical perspective reinforces a transmission view of teaching mathematics (McNamara, 1991). Other critics believe that mathematics pedagogical content knowledge is situationally and experientially based, grounded in classroom experience (Aubrey, 1994).

However, if we situate this perspective in the pedagogical relation space that I suggested in the previous chapter it prompts us to consider the question of the subjectivity of the teacher and students. It is implied in this technical perspective that the teacher is a self-transparent subject, master of knowledge (pedagogical content knowledge) for teaching. This, as we have seen, is

impossible for a being in language. This implies that the teacher misrecognizes her existence in the symbolic order. In Maturana's sense the teacher in this perspective is an observer in objectivity-without-parenthesis. von Foerster (1991) observes:

> The power of position is trust in the abilities of ultimately describing this universe without the properties of the observer entering his descriptions – 'Objectivity'. The notions of Truth and Objectivity guarantee the popularity of this position, the former promoting authority- 'It is as *I* tell it' – the latter removing responsibility – 'I tell it as it *is*'. Moreover, by separating oneself from the universe, one separates oneself from others as well. Hence, without consequences for oneself one is now in a position to tell the others: 'Thou shalt…' or 'Thou shalt not…' The method here is to reject reflexivity. (p. 65)

Another way of looking at this perspective is through the relationship of knowledge and ignorance. Knowledge has the other as ignorance. The teacher desire is structured in a way to transmit knowledge to the students who are supposedly "ignorant". The teacher desires this ignorance. Questions like, how do I express myself well so that someone who does not know this would understand? are manifestation of this desire. This means that in a pedagogical relation structured in the technical perspective, ignorance embodies the impossible *jouissance* that the teacher desires. However *jouissance* is prohibited, what emerges from this though is surplus enjoyment that can be thought as pleasure in pain. This surplus enjoyment is embodied in the student(s). That is to say the student comes to be that (quasi-object) *objet petit a*, the object-cause of the teacher's desire. As a cause of the teacher's desire 'the student' is not its object. All that the student does animates the teacher's desire. The teacher incessantly searches for something from the student that will guarantee the success of her transmission of knowledge: interest, ability, attentiveness, silence and so on.

This explains why teachers have to transform mathematics knowledge into forms that are comprehensible, of interest, suitable to the ability of students

(Shulman, 1987). Since desire cannot be satisfied, the teacher preoccupies herself with different ways of trying to represent knowledge so that students are able to grasp it. This is not easy, as Anderson (1989) notes some comments from his student:

> Wilson and Shulman wrote about representations for subject matter that teachers use to help if their students understand new material. It is difficult in some subjects to have many different representations for the same subject, for instance, in math. Some material in math can basically be explained in only one way. (p. 93)

In addition, in this perspective teachers concentrate much on the preparation of lessons rather than the actual practice. Also, any kind of reaction from the students is considered as a constraint to the transmission of knowledge. This means it should be "managed" or controlled, which helps to explain why student teachers preoccupy themselves with the questions of classroom management and control.

How are we to explain why student teachers (and other teachers) persist in teaching for procedural knowledge in mathematics education? Here we have to understand the role of affect/emotion/*jouissance* in psychoanalysis and enactivism. Emotions provide a background that makes possible our actions and specifies the domain in which they take place (Maturana, 1988a). This means that the student teachers' or the teachers' decision for teaching for procedures is emotional and not rational. The role of fantasy in Lacanian theory is also crucial here.

> ...fantasy works both ways, it simultaneously *closes the actual span of choices* (fantasy renders and sustains the structure of the forced choice, it tells us how we are to choose if we are to maintain the freedom of choice – that is, it bridges the gap between the formal symbolic frame of choices and social reality by preventing the choice which although formally allowed, would if in fact made, ruin the system) and *maintains the false opening*, the idea that the excluded choice might have happened, and

does not actually take place only on account of contingent circumstances. (Zizek, 1997, p. 29)

Perhaps this explains the persistence of teachers teaching for procedural knowledge in mathematics education and the reasons given for the decisions. Eisenhart et al. (1993) review a number of reasons why the student teacher in their study might persist. These include pressure to prepare students for the test, to cover designated topics in the curriculum, and not always having the pedagogical knowledge to teach for conceptual knowledge. These decisions are emotional and permeated by *jouissance,* albeit a surplus enjoyment. Is not teaching for mathematics procedure a perfect guarantee for the teacher's success for transmission of knowledge? Is it not a guarantee for jouissance albeit surplus enjoyment; that is, pleasure in pain? The next section discusses the cognitive perspective, which challenges the technical perspective.

Cognitive Perspective

Cognitive perspective has been the centre of discussion in the literature of learning to teach and teacher knowledge. The impetus for this perspective comes from the work of Piaget (Chickering & Reisser, 1993). According to Chickering and Reisser, there are three fundamental principles of cognitive approach. These are:

1. Cognitive structures: individuals form cognitive structures to make sense of what they experience

2. Developmental sequence: the cognitive structures evolve becoming more complex, differentiated and integrated

3. Interaction with the environment: both maturity and readiness within the person and stimulation from the environment are essential for growth to occur.

The impetus for this perspective in the learning to teach literature comes from the work of Lortie (1975). According to Lortie, entrants to teacher education programs have typically been exposed to over 13,000 hours of schooling prior to teacher education. They have viewed this teaching without access to theories of

teaching and learning. Unlike entrants to other professions such as engineering, prospective teachers bring to teacher education more than their desire to teach; they bring their implicit institutional biographies that inform their knowledge of the student's world, of school structure and of curriculum. The technical perspective does not address the hidden significance of biography in the making of a teacher, particularly as it is lived during student teaching (Britzman, 1986). The student teacher must try to understand his or her own institutional biography as it is evoked by the return to classroom life while at the same time educating others and learning the teacher's world.

The cognitive perspective has been very useful in unpacking the meaning, which student teachers construct from their experiences. It is argued from this perspective that for professional growth to occur, student teachers' prior beliefs must be modified and reconstructed. Teacher education programs based on a constructivist perspective organize experiences in which student teachers learn to reflect on their beliefs and hence reconstruct new knowledge.

Cobb and Steffe (1983), coming from a constructivist framework, offer a perspective on the conceptualization of pedagogical content knowledge in mathematics education. They maintain that teachers' knowledge about teaching mathematics should be grounded in what we know about how children construct mathematics ideas. This knowledge is generated more from psychological domain than from a mathematical one. The contribution of research on children's learning to teacher education consists of providing teachers with the kind of knowledge and insight that allows them to construct viable models of children's' learning of mathematics.

That is to say, teachers must try to infer, from what they can observe, what the students' concepts are and how they operate with them. Only on the basis of some such hypothesis can teachers devise ways and means to orient, direct, or modify the students' mental operating. This is a context in which the constructivist approach and its analysis of conceptual development seemed promising. (von Glasersfeld, 1991, p. 23)

There are a number of projects and movements in mathematics education, which support the notion of constructivism. Prominent among them are the reform movements in mathematics education, particularly those in response to the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards (1989) and Principles and Standards (2000). In the light of the NCTM Standards, the role of teacher education is to enable teachers to choose worthwhile tasks; orchestrate classroom discourse; create a learning environment that emphasizes problem solving, communication and reasoning; and develop the ability to analyze their teaching and student learning (NCTM, 1991).

The Cognitively Guided Instruction (CGI) project considers the question of whether teachers can better facilitate student learning when they are aware of how students learn mathematics. Fennema and Franke (1992) conclude that the CGI studies support the idea that knowledge of children's thinking, when it is integrated, robust, and a part of the known curriculum, can influence the teaching and learning of mathematics. Implicit in this curriculum is the assumption that teachers' cognitions are of critical importance. The fundamental requirement of CGI is that teachers, as thinking beings, must internalize and utilize knowledge about students' learning in their individual instructional program.

Cognitive Perspective and Teacher Education

An example of the way CGI is applied in teacher education is contained in Vacc and Bright (1999) report on the study designed to examine the effect of introducing preservice elementary school teachers to CGI. Vacc and Bright describe CGI approach as follows:

> CGI is an approach to helping "teachers use knowledge from cognitive science to make their own instructional decisions" (Carpenter & Fennema, 1991, p.10). Children's knowledge and the teacher's understanding of that knowledge are central to instructional decision making. Teachers plan instruction using research based knowledge about children's mathematical

thinking and well-defined taxonomies of problem types and children's solution strategies for arithmetic operations (Carpenter & Fennema, 1991; Carpenter & Moser, 1983). Teachers seek specific information about individual students' thinking and understanding and then adjust the level of content to match individual performance levels. (Vacc & Bright, 1999, p. 1) Therefore there are three components to CGI approach: knowledge from students thinking, knowledge from research base on students' thinking and the influence of these on instruction.

Student teachers in Vacc and Bright's study were introduced to problem types for the basic operations and children's solution strategies (from Carpenter, Fennema and Franke, 1993), and knowledge of children's geometrical thinking (from Lehrer, Fennema, Carpenter and Osana, 1992) during their mathematics methods course. To assess the effect of CGI on the student teachers a CGI Belief Scale (from Peterson, Fennema, Carpenter & Loef, 1989) was used to assess changes in the pre-service teacher's beliefs about teaching and learning mathematics. In addition to this some students were observed during their student teaching.

According to Vacc and Bright, student teachers in their study "appeared to change their beliefs to a more constructivist orientation about the learning of mathematics during their teacher-preparation program". However, there were some exceptions as described, for example, in Vacc and Bright's observation of a student teaching fractions:

> Andrea appeared uninterested in hearing about interpretations that the students might be developing, and there was no discussion of the quantities that any of the fractions might represent. When Andrea asked at the end of the lesson what the students had learned about fractions, one responded. "The top number is the numerator and that's the one that we chose stuff to put in, and the bottom number is the denominator and that shows all the things that are together." The parts of the symbol seemed to have been learned as isolated from one another, students did not seem to have had a chance to make sense of fractions as quantities. This lesson,

which seems to be representative of Andrea's instruction during the later part of student teaching illustrates that her focus during mathematics instruction became more directed toward procedure building with the teacher being the ultimate authority on what procedures were to be learned. (Vacc & Bright, 1999, p. 7)

The constructivist perspective has been very useful in showing the meaning of teaching as complex cognitive activity. Three processes have been identified that make teaching a complex cognitive activity: multidimensionality, simultaneity and unpredictability. Constructivism emphasizes the importance of understanding student's mathematical inventions. What is becoming increasingly recognized as well is that teachers construct ideas. The realization that teachers, as well as their students are cognizing subjects leads to research questions that focus on how and under what conditions teachers become adaptive agents as well as cognizing agents. Much of the current research on teachers' beliefs and conceptions addresses this issue of context and adaptation.

Even though the constructivist perspective offers insightful, challenging suggestions for improving teacher education, there are tensions, such as what Vacc and Bright describe above, in implementing the ideas. Nilsen (1995) reports the case of a student teacher who tried to use constructivist ideas to show the children that multiplication is something useful when they are dealing with many numbers. She selected five children from the group (the rest were sitting on the carpet), and asked them to raise their hands and show all their fingers. She wanted to demonstrate that five plus five ten times equals fifty. The children, however, only mentioned ten. After all they know they have ten fingers! After several attempts of trying to rectify this, the student teacher found herself in a situation where she was not in control and resorted to the traditional method. Borko et al., (1992) give a similar account of a student teacher trying to use students' experiences in teaching fractions and resorting to conventional methods after the situation became too complicated.

It is easier to associate the problem above with the students' lack of pedagogical content knowledge. In fact, Vacc and Bright thought that lack of

experience and levels of mathematical understanding might have contributed to student teachers use of CGI principles. However, similar observations have been made with in-service teachers. For example, Simon, Tzur, Heinz and Kinzel, (2000) report some tensions on their research project focused on understanding how teachers' practices develop from ones based on traditional conceptions of mathematics, learning, and teaching toward practices based on conceptions that are more consistent with principles underlying current mathematics education reform efforts. Teachers in this project were engaged in a course conducted as a teaching experiment with the researcher (Simon) as the instructor. Teachers were introduced to "conception-based" (emergent and constructivist) perspective whose assumptions are:

1. Mathematics is created through human activity. Humans have no access to a mathematics that is independent of their ways of knowing.
2. What individuals see, understand, and learn is constrained and afforded by what they currently know (current conceptions).
3. Mathematical learning is a process of transformation of one's knowing and ways of acting. By using the term *transformation*, we mean to indicate that learning involves a modification of existing ideas, not just the accumulation of additional ideas. (Simon et al., 2000, p. 584)

Later on during the course in their study Simon et al., observed that the teachers understood the conception-based perspective differently from the researchers (instructors). An example might be seen in Simon's observation of the discussion between the instructor and the teachers on how children learn a concept of number from counting:

The teachers explained the transition to number as the result of the child's learning to associate a number name with sets of objects for which it is appropriate. This explanation was clearly incompatible with Simon's understanding of what the child does not yet know – that objects can be quantified. In other words, although the child may be able to make qualitative distinctions between many and few, she has no idea that one can quantify the manyness of a set. The teachers seemed to assume that

children see quantity and that they develop a set of conventional labels (numbers names) for describing what they see by repeatedly relating number words with the perceived quantities. (Simon et al., 2000, p. 588)

Another example comes from the researchers' observation of a teacher teaching long division using-base ten blocks. They observe:

Ivy's approach was to foster understanding of the long-division algorithm through showing students the correspondence between steps of their base-ten block solutions and steps in the algorithm. This approach seemed be based on two assumptions: (a) understanding is (at least in part) knowing the connections among various aspects of the mathematics, and (b) situations that make particular mathematical connections readily observable can be created. (p. 591)

Simon et al. characterize the teachers' perspective as "perception-based" in contrast to conception based and tradition based. Thus perception-based involves:

Perspective on mathematics

- Mathematics is an interconnected and understandable body of knowledge.
- Mathematics exists independently from human activity, and therefore mathematics is accessible *as is* to all learners

Perspective on mathematics learning

- Knowing mathematics with understanding involves firsthand experience in perceiving (discovering) the mathematics
- The mathematics that is perceived is the same for each individual. Individual differences are accounted for by differences in what aspects of mathematics are known (have been perceived) at a given point of time (Simon et al., 2000, p. 593)

Simon et al., seem to suggest that perception-based perspective is the result of teachers assimilating new knowledge (conception-based) in their prior knowledge. Also they suggest that this may be a stage in teachers' development

of conception based perspective. But how are we to explain the situation faced with the student teacher in Nilsen (1995) above?

Jaworski (1997) articulates the dilemma experienced by teachers in her study.

> The dilemma, which I see, voiced in these teachers' statements, concerns interaction between students and the teacher with regard to the construction of knowledge. The student's task is to construct mathematical knowledge. The teacher's task is to support and challenge this construction. This is easy to say, but what does it mean? Edwards and Mercer (1987) articulate the dilemma aptly when they describe teachers as having to "inculcate knowledge while apparently eliciting it." (p. 11)

That is to say, on one hand teachers are required to respect students' experiences and how they think. On the other hand, teachers have to respect the mathematics concepts. This then is the challenge in constructivism. There are two ways in which teachers have tried to deal with this challenge. The first way is to continue with business as usual, that is to continue to teach for procedural knowledge, as was a case with the student in Vacc and Bright's study. The second way is to teach using the perception-based perspective as observed by Simon et al. above. How then, are we to explain this challenge?

Psychoanalytic and Enactivist Reading of Cognitive Perspective

Davis and Sumara (1997) have this to say with regard to constructivism:

> However, while having served a critical role in interrupting commonsense assumption about cognition and the modernist mindset, Constructivist accounts tend to share a tenet with representationism. In both orientations, the cognizing agent is cast as fully autonomous. And so like representationism, constructivism is a theory of knowledge and experience that seeks to bridge perceived gaps between knower and world and among knowers. The belief in the isolated subject further supports the notion that the "individual" is contained in a context rather

> than regarding the individual as an integral part of relational fabric. This
> belief we argue, is monological; that is, the idea of an isolated subject
> presumes a solitary truth-determining authority. The relations among
> knower and known are not considered the most important feature in the
> development of a theory of cognition. (p. 109)

There are two ways of reading the above critique of constructivism. One is to read the problems or difficulties of constructivism as being merely epistemological obstacles to be eliminated. The other is to read it as an expression of an ontological problem; that is, a problem inherent to the nature constructivism itself[4]. In the field of mathematics education, there are various perspectives that approach the difficulties with constructivism as epistemological obstacles. For example, to attend to the way constructivism casts an individual as isolated from the relational fabric, social constructivists focus on the importance of the social as well as culture in the teaching and learning of mathematics. Social constructivists employ the work of Vygotsky. According to Vygotsky, "higher voluntary forms of human behavior have their roots in social interaction, in the individual's participation in social behaviours that are mediated by speech" (Minick, 1996, p. 33). Following this work in social constructivism, notions like "emergence", "definition of the situation", "negotiation", "culture of the classroom" and many more came into use (Bauersfeld, 1995). For example, Cobb, Wood and Yackel, (1991) explore the relationship between a constructivist approach to mathematics teaching and social and cultural norms in mathematics classrooms. There is no doubt that work done along this line has contributed a lot in the teaching and learning of mathematics. However I would like to suggest that by simply adding the social, or cultural in constructivism, social constructivists generate their own impasse; the impasse is structurally similar to radical constructivists. For example, the question arises as to how the individual internalizes the social? My point is that as long as we try to resolve problems as outside obstacles, as epistemological, the result is the shifting of one ground or

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[4] Here we must take ontology in psychoanalytic sense as opposed to the philosophical sense. Ontology in psychoanalytic perspective is neither being nor non-being.

foundation to the other: from focusing on the individual to the social or culture. That is to say what we have is an incessant displacement of various constructs and problems arising from focusing on these constructs: social, culture, context and so on. Mason and Spencer (1999) sum up the nature of this incessant:

> When education is dominated by abstraction and generalization, there is an issue of application: how do students know to apply that knowledge in a given situations or context?
>
> When education is dominated by training in behavior, there is an issue of transfer: what enables a student who has mastered a skill to know to apply that skill in a novel context, and to generate it? (Detterman and Sternberg, 1993)
>
> When education is dominated by specific practical situations and contexts, there is an issue of generalization: how do students come to stress and ignore appropriately, since they may stress features that are irrelevant and ignore features that are relevant?
>
> When education is dominated by apprenticeship-like participation in a community of practice, so that training and education are context-dependently situated, there is an issue about extending contexts: how do experts and novices come to recognize similarity between contexts which enable them to transcend the situation in which they encountered an idea or topic, and employ it in a new context? (p. 150-51)

How then are we to avoid this kind of an incessant? What I am suggesting is to approach the problem in constructivism as inherent to the nature of its object of knowledge. That means to approach the problem by attending to that which is at stake in constructivism regarding subjectivity: the notion of an individual as a fully autonomous agent (Davis & Sumara's critique). Put differently, the problem is not just that by casting an individual as an autonomous agent constructivists neglect the social or the culture but rather the problem is in the way subjectivity is conceptualized in constructivism. What is missed in this constructivist subjectivity is what is articulated in both enactivist and psychoanalyst perspectives, that the subject is the being-in-language, divided.

To highlight the impasses confronting constructivists' notion of subjectivity let me refer to the way self-consciousness is discussed in constructivism and psychoanalysis. According to von Glasersfeld (2002), throughout his work, Piaget recoiled from discussing about the nature of consciousness. For example, in his "Insights and Illusions of Philosophy" (1971), Piaget disagreed with the ideas of consciousness given by Bergson, Husserl, Sartre, and other philosophers, but did not present an explanatory model of his own. In the paper in which von Glasersfeld pays homage to Piaget he explains the experience of self-consciousness as follows:

> We have no idea what it is that gives us this internal awareness and the power to reflect. But we know that we have it. As you are listening to me now, you can become aware of your own listening. And as I am speaking to you, I can become aware of what I am doing and ask myself, why can I not say all this more simply? – We know that we can reflect, but we do not know how.
>
> We may call it awareness or consciousness, and then put a 'self' in front of it, but this does not explain – we have no model of mechanism that could produce such an effect. (von Glasersfeld, 2002, p. 9)

In the same way, the mechanism of self-consciousness is not theorized in psychoanalysis. As Lacan (1977) notes,

> The dynamic that is attached to the consciousness as such, the attention the subject brings to his own text, remains up to this point, as Freud has stressed, outside theory and strictly speaking, not yet articulated. (p. 83)

That is to say, both Lacan and von Glasersfeld acknowledge that the mechanism or dynamic of self-consciousness is not yet articulated. However they differ in the way they locate and talk about self-consciousness. In psychoanalysis and enactivism it is only because a human being is a being-in-language that we can discuss the experience of self-consciousness (Maturana, 1988a, 1988b; Lacan, 1977). From enactivist and psychoanalytic perspectives, self-consciousness is not the same as self-transparency or self-presence of the modernist subject.

Self-consciousness involves splitting between the subject of the enunciation and the subject of enunciated and these do not coincide. "I am conscious of myself only in so far as I am out of reach to myself qua the real kernel of my being ("I or He or it (the thing) which thinks")" (Zizek, 1998, p. 15).

A close reading of the von Glasersfeld quote above shows that Piaget or von Glasersfeld realize this splitting of the subject. However, because Piaget elevates the subject to an autonomous agent, he perceived this as a state or level an individual can attain. According to von Glasersfeld (2002), in *La prise de conscience* (1974), Piaget "provided evidence that consciousness is not an all-or-nothing phenomenon, but has several successive levels" (p. 10). This way of conceptualizing consciousness is due to Piaget's (constructivist) developmental theory of cognitive structures.

> Thus he [Piaget] assumes a cognizing entity and proposes that this entity gradually distinguishes itself from all it is able to isolate and categorize as 'external' in its active experience (von Glasersfeld, 1995 p. 62)

And,

> ...at the termination of this [sensorimotor] period, i.e., when language and thought begin, he [the child] is for all practical purposes but one element or entity among others in a universe that he has gradually constructed himself and which hereafter he will experience as external to himself. (Piaget, 1967, p.9 quoted in von Glasersfeld, 1995, p.62)

There are limitations with this Piagetian (constructivist) discussion of self-consciousness. As I have noted above, it seems that von Glasersfeld realized the splitting of the subject. Yet in the quote above, Piaget describes an individual as an entity that develops by distinguishing itself from an external. It is in this way that constructivists miss the radical decenteredness and reflexivity of the subject articulated in enactivist and psychoanalytic perspectives: "a mode of reflexivity that necessarily incorporates a passage through the Other [symbolic order or language], not as a reflection of the self but as a radical difference from the self, a radical difference to which, paradoxically, the very movement of reflexivity is addressed" (Felman, 1987, p. 59).

I want to suggest that constructivist theoretical lapse is made possible by masking this decentredness and reflexivity of a subject with its notion of an autonomous individual. Piaget manoeuvres this reflexivity by his development theory, taking self-consciousness as a state level to be attained by a child's development. Here lies what Lacan calls a confusion of development to development of mastery (Lacan, 1998). That is to say, development is progression towards the mastery of ego-self: "I am the master, I progress along the path of mastery, I am master of myself as I am of the universe" (Lacan, 1998, p. 56). In this view constructivists following Piaget by focusing on the ego-self operate on what Maturana (1988) calls "objectivity-without-parenthesis", mis-recognizing the individual from being the being-in-language.

At this point it is worth noting how the above constructivism theoretical limitations relate to the dilemmas discussed above in teaching and learning practice. I think one of the dilemmas in constructivism is the misrecognition of subject as the ego-self as opposed to the divided subject of language. We should recall that the modality of "freedom" of the divided subject is that of forced choice, of a situation in which I am free to choose on condition that I make the right choice. What we have in constructivism is that the choice is "really free". Paradoxically, it is this "really free" choice in constructivism that is frustrating for teachers and students. To elaborate this point let us take example from the class of grade three (Ball, 1994). In this particular class, Ball's students drew pictures of 4/4 and 5/5 correctly but then believed that there were not the same amount. Ball describes the reasoning of one student (Sheena) as follows:

> It was important to me that Sheena—a student of colour, a quiet girl—displayed confidence in herself and her ideas to defend them in the face of classmates' objections. And she is right, given the question she has framed ("Which way of cutting the cookie –into fourths or fifths—will serve more friends?"). (p. 9)

Here we have a sense of what this freedom or liberation entails in a constructivism class. The question or dilemma Ball faces is how to help Sheena realize that the two amounts are the same without interfering with her confidence.

In this chapter, I have attempted to read the technical and cognitive perspectives of knowledge in mathematics teacher education using psychoanalytic and enactivist perspectives. In the next chapter I present a psychoanalytic and enactivist reading of student teachers narratives of their experiences as they learn to teach mathematics.

Chapter 4

BECOMING A MATHEMATICS TEACHER

The liminal space indicated by hyphenation "student-teacher" is a haunted and generative space, full of tales told to anyone who will listen.

David Jardine, 1998, p.123

Zizek (1999) tells a story of a mad man who thought he was a grain of corn. After being cured and sent home he immediately returned to the mental institution, explaining to the doctor his panic: "On the road, I encountered a hen and I was afraid it will eat me!" To the doctor's surprised exclamation, "But what is a problem now? You know you're not a grain but a man who can not be swallowed by a hen!" The mad man answered, "Yes, I know I am no longer a grain, but does the hen know it?" Zizek notes that, although this story might be nonsensical at a factual level; that is, whether you are either a grain or not, it is sensible if one replaces 'a grain' with some feature which determines one's symbolic identity. Is it not what happens with student teachers as they learn to teach precisely the question "does the 'Other' know I am a teacher"? The 'Other' is here epitomized by students and cooperating teachers. What does it mean to learn to teach?

In this chapter I discuss the experiences of student teachers as they learn to teach mathematics. My discussion here is based on a psychoanalytic and enactivist reading of the student teachers' narratives of their teaching experiences. The focus of this reading is to present the dynamics of learning to teach in a way reflected in the words of Jardine (1998): "The liminal space indicated by hyphenation 'student-teacher' is a haunted and generative space, full of tales told to anyone who will listen" (p. 123). My intent of reading these narratives is not to describe or interpret the individual meanings or tales of the student teachers (although this may happen). Rather, it is to use these readings, as a pedagogical space for attending to the question of knowledge and pedagogy which is central to this dissertation.

In the following section I briefly present what I have read about student teaching in teacher education. Then I discuss the psychoanalytic and enactivist approach. Finally a psychoanalytic and enactivist reading of the student narrative will be presented.

Student-teaching

As I have mentioned in Chapter 1, one of the observations about student teachers learning to teach is that student teachers learn through stages. The most influential study in this direction is that of Fuller and Bown (1975). Fuller and Bown identify three discrete stages of student teachers' development: survival, mastery and finally a stage where student teachers either settle into routines and become resistant to change, or become consequence oriented, that is, concerned about their impact on pupils and responsive to feedback about their teaching. Put differently, student teachers progress from survival concerns through task concerns to impact concerns. Following this, a number of studies have been done both in terms of elaborating and extending the stage theory of student teachers' development.

The stage theory of student teachers' development has been criticized for being technical and ignoring the complexity of teaching and learning processes. Previously I have noted how researchers recognize that student teachers bring their previous school experience to the learning to teach. I have also noted that the impetus for this recognition comes from the work of Lortie (1975). Lortie observed how entrants to teacher education programs, unlike entrants to other professions, such as engineering, have typically been exposed to over 13,000 hours of schooling prior to teacher education. Accordingly, student teachers bring with them experiences from their schooling years that influence their learning and teaching. The technical perspective does not address this recognition. From this recognition of the influence of student teachers' prior experiences to their learning, researchers focus on the students' belief systems as they begin their program or student teaching. Student teachers' development

is conceptualized as changes of the students' belief systems as they learn to teach. Examples of these studies are those using CGI framework as discussed in Chapter 3. This way of conceptualizing the student teachers learning to teach has been criticized as focusing on the individual at the expense of the context and culture in which student teachers are imbedded.

Following the work of Lave and Wenger (1991) on situated cognition or situated learning, researchers in teacher education are now focusing on student teachers and their relation to culture and context in which they learn. Lave and Wenger do not view learning as individual cognitive processing but as a process of participation in 'communities of practice'. Initially this participation is legitimately 'peripheral'. "Overtime the learner increases in engagement and complexity with the practices of the community: he or she moves centripetally towards full participation, and in so doing both absorbs and is absorbed in the culture of practice" (Maynard, 2001, p. 41). The point to be noticed is that, with this perspective learning within the community of practice involves becoming a different person; it involves the construction of identities. That is to say, student teachers' development can be seen as a process of acquiring understanding about teaching and learning and a sense of identity as teacher.

Lave and Wenger's work in teacher education opened the importance of identity for students learning to teach. It is a commonplace in the literature on learning to teach to discuss how student teachers negotiate their identities during teaching. However, this way of conceptualizing identity has been criticized by researchers deriving their frameworks from post-structuralism and postmodernism. It is argued that there are problems in the way context and transfer are theorized in situated cognition. These problems stem "from a view of context as something grafted onto single model of cognitive development" (Walkerdine, 1990, p. 51). Walkerdine proposes a theory of practices in which "we might understand subjectivity itself as located in practices, examining the discursive and signifying methods through which a person becomes 'subjected' in each practice. As Britzman notes,

There is a distinction between learning to teach and becoming a teacher. Indeed, the significant albeit hidden work of learning to teach concerns negotiating with conflicting representations and desires. One must ferret out how multiple interpretations of the meanings of social experience come to position one's identity as a teacher. This involves scrutiny into how we come to know ourselves when we are trying to become a teacher. (Britzman, 1992, p.36)

It is possible to read the above discussion about student learning to teach as an irreducible plurality of particular perspectives on conceptualizing how student teachers learn to teach. In addition, it is also possible to view these different perspectives as a manifestation of a progressive improvement of conceptualizing how student teachers learn to teach: from the stage theory (neglecting the student teacher's biography), to cognitive development focusing on the individual biography (neglecting the context), to situated cognition focusing on context, i.e. the community of practice (neglecting the discursive and signifying methods through which student teachers are subjected) and finally to poststructuralism focusing on these discursive and signifying methods.

As I have argued previously, this incessant displacement of perspectives leaves untouched the Real kernel of the question of student teacher learning to teach. Once again we must transpose the epistemological obstacle apparent in the perspectives above to the ontological limitation. We should remember, ontology here must be understood in the sense taken in psychoanalytic perspective: neither being nor non-being. That means we must take these particular perspectives on how student teachers learn to teach as responses to the impossible Real, which can not be symbolized, yet, also, the remainder of symbolization. That is to say, we must approach the question of student teachers learning to teach from the student teachers' subjectivity. In the following section I discuss how we might begin to understand student teachers' experiences of learning to teach from psychoanalytic and enactivist perspectives.

Identity and Identification in Psychoanalysis and Enactivism

To appreciate the psychoanalytic and enactivist reading of student teachers' narratives of their experiences three points are important. First, as I have discussed in Chapter 2 from a psychoanalytic and enactivist perspectives, human being is a being-in-language; that is, the subject is divided between the subject of enunciation and the subject of enunciated. Second, from Lacan's scheme, the field of meaning, symbolic order or the Other is also lacking. That is to say the field of meaning cannot ground itself and achieve closure; that is, there is no metalanguage. Third, we must situate this reading on what I have called the pedagogical relation.

From the situated cognitivist and poststructuralist perspectives we learn that student teachers' learning to teach involves negotiating identities. According to poststructuralists the processes of identification involve how individuals are subjected to different discursive practices. We can understand identification in psychoanalysis through the three Lacanian registers: the imaginary, the symbolic and the Real. For Lacan the subject is a subject of a signifier, which represents him or her for the other signifier. Symbolic identification involves identification with the signifier such as 'teacher'. Through this the subject is loaded with a symbolic mandate: he/she is given a place in the intersubjective network of symbolic relation. "This mandate is ultimately always arbitrary; since its nature is performative, it cannot be accounted for by reference to the real properties and capacities of the subject" (Zizek 1989, p. 113). Loaded with this mandate the "subject is automatically confronted with '*Che voui*?', with the question of the Other i.e., what does the Other want?" (Zizek, 1989, p.113)

Imaginary identification involves misperceiving the effects of the play of signifying differences of signifiers as positive properties of an identity such as a teacher. It involves identifying with the signified or image that attaches to the signifier. Meaning, therefore, involves the interplay of imaginary and symbolic identification.

The imaginary and symbolic identification are similar to an observer in the objectivity without parenthesis and objectivity with parenthesis in Maturana's scheme. According to him the observer in the objectivity without parenthesis desires for an independent entity in his or her explanations. The observer in objectivity in parenthesis accepts his or her being in language. He or she accepts that as a human being operating in language, he or she cannot distinguish what is illusion from what is perceptive.

What I have just said in relation to identification is not that much different from the poststructuralist perspective. It is the Lacanian register of Real that marks the difference.

> Here we see the thin, but crucial, line that separates Lacan from "deconstruction": simply because the opposition between nature and culture is always already culturally overdetermined, i.e., that no particular element can be isolated as "pure nature," does not mean that "everything is culture." "Nature qua Real remains the unfathomable X which resists cultural gentrification." Or to put it another way: the Lacanian Real is the gap which separates the Particular from the Universal, the gap which prevents us from completing the gesture of universalization, blocking our jump from the premise that every particular element is P to the conclusion that all elements are P. (Zizek, 1993, p. 129)

This distinction is crucial for understanding pedagogical relation. The Real constitutes the (internal) limits of the symbolic order (the field of meaning). Put differently, it marks the limit of meaning and therefore it marks the limits of symbolic and imaginary identification. The Real is related to the affect and emotions in human subjectivity.

As Zizek notes, the Real is the "unfathomable X" that resists our symbolization, our universalization. Herein lies the paradox in psychoanalytic reading. How then are we to read or talk about that which resists our symbolization? How are we to read student teachers' narratives? In the following section I present a psychoanalytic and enactivist reading of the student teachers' narratives.

Reading Student Teachers Narratives

In psychoanalytic inquiry there are two ways of reading human experiences: interpretation or symptomatic reading and the reading of the fantasy; that is, a construction. The symptomatic or interpretative reading, is what Jardine (1998) calls the pathological/curative reading. The function of interpretation is curative. Knowledge of fantasy is knowledge in the Real. The Real is that which cannot be symbolized. Therefore, knowledge of fantasy cannot be interpreted. It can only be (re)constructed. A construction is a logical construction of events, which might or might not have happened. The function of a construction is pedagogical. In the following sections, in addition to interpretation, I attempt to read the student teachers' narratives using the method of construction. It should be noted that the narratives are student teachers' own stories of their experiences. It is in my reading of these narratives as presented in this chapter that attempt to read fantasy.

Symbolic and Imaginary Identification

It is in the head

> I remember the first time I was going to teach. I woke up early in the morning to prepare myself. This was an exciting day for me and my family. I never really wanted to be a teacher. I wanted to be an engineer. But here I was going to be a teacher. I made sure I read and understood well what I was going to teach. I took a very small piece of a paper and made a few points to remind myself during the teaching. I was not going to take any book or notes. This way, students would know that I knew what I was teaching. All was in my head. (Student teacher narrative)

Reading this student teacher's narrative describing his first day of student teaching reveals a sense of familiarity to those who are involved with student teaching. We all know either from our own experiences as student teachers or from observing student teaching how exciting is the first day of teaching. From this background, one might therefore dismiss this as a typical first day experience

that student teachers eventually overcome with practice. Yet, a close reading of this narrative reveals something more than just a typical first day teaching experience. What does it mean to be a teacher?

There are different ways of reading this student narrative. For example, one might read this from a constructivist perspective as revealing one student teacher's belief about what it means to be teacher. The student teacher believes that the teacher has to be one who knows. Also, this student teacher believes that knowledge is held in the head. In order to demonstrate this to the students he does not carry books or notes for reference precisely because all knowledge is in his head. One could also interpret this student narrative from a poststructuralist perspective where the concern might be how the student teacher is positioned by different discourses. Here one might invoke the "the teacher as an expert" myth discussed by Britzman (1991) and read the student teacher narrative as an example of how students live this myth. As I have mentioned earlier there are limitations to these interpretations regarding student teachers learning to teach.

We now turn to a psychoanalytic and enactivist reading of the student teacher narrative. Here, we must approach the question of what it means to be a teacher as a question of symbolic identification: identification with the signifier teacher. This identification with the signifier 'teacher' can be thought of as a question mark that troubles the subject (student teacher) and defies his or her attempts to discern its (teacher) meaning. This is because, in itself, the signifier teacher does not mean anything. The meaning and or identity of teacher acquires consistency only as a result of its entering into a differential relation with other signifiers. That is to say, its identity resides outside itself. In other words, the signifier serves as an enigma that promises meaning. Further, it is precisely because the signifier simultaneously does not mean anything and promises a meaning that the subject (student teacher) is engaged in a search for identity and struggle for meaning. We can now read the student teacher narrative as interplay between his symbolic and imaginary identification. The student teacher acquires

an imaginary identity (self-identity) by misperceiving the meaning of the teacher as one that knows, one who holds knowledge in his head.

The Role of Fantasy

As I have mentioned before, symbolic and imaginary identification never end without a remainder. There is a 'beyond' meaning. What I am suggesting here is what Maturana puts succinctly, that the decisions for our actions are emotional and not rational. To appreciate this contribution we need to take into account the role of the affect and emotions in identification.

In a psychoanalytic perspective this means taking into account the dimension of the Real. We can approach this dimension by reading the above student teacher narrative side by side with the following narrative. We might even imagine that the student in the first narrative would have the same experience as the one below.

The Student Who Knows Very Well

In my Math 20 class, there is a group of three students who sit at the front of the room, they understand the concepts extremely well. During a lecture a week ago, one of these students was bored with the lesson because he felt that he could do the work without any difficulties and so made a comment why should I bother going over the examples step by step if they understood what was to be done. Well to rectify the situation I gave the homework assignment to everyone and said that anyone who felt that they could do it, feel free to and those that still needed help could follow along the with the examples. I was continuing to do on the board. Half the class did start their homework however the other half asked me to do about four more examples. While I was walking around to see if anyone was having problems this student asked me why I felt it was necessary to follow all the steps. I found out he understood when I said others need those steps to understand how to do the homework, but he thought it was a waste of his time. Ever since that class he has sat at the front of the room and has this look on his face like he is better because he does not need extra help. It is very frustrating. How would anyone deal with students who sit directly in the front and stare out

into space not because they don't understand but because they understand too
well, and don't see the point? (Student teacher narrative)

It is possible to read this student's experience as a common student teaching situation requiring a simple intervention. We all know that students are not the same and one should expect to find students with different abilities in any class. What the student teacher needs is facilitation and intervention on how to deal with this situation. She might be advised to give extra work or challenging work to the students, who do not need more examples. It is also possible to interpret the student teacher's teaching methodology as being consistent with typical or traditional ways of teaching mathematics. Thus:

> The program is fairly clearcut. We have problems to solve or a method of calculation to explain, or a theorem to prove. The main work will be done in writing, usually on the blackboard. If the problems are solved, the theorems proved or the calculations completed then the teacher and the class know they have completed the daily task. (Davis & Hersh, 1981, p.3)

It is not surprising that some students might be bored. We might add that this student teacher's experience reflects her beliefs about teaching and learning mathematics arising from what she has experienced during her schooling years. Yet while these interventions might help the student teacher somehow ease her frustration, there is something insisting in this narrative. "How would anyone deal with students who sit directly in the front and stare out into space not because they don't understand but because they understand too well, and don't see the point?" How are we to read this student teacher's frustration?

Here we need to approach this question through the dynamics of symbolic identification and the Lacanian Real. We should recall that the Lacanian Real marks the limits of symbolic order or the Other. We could say that something is missing from the symbolic order, the final word or the signifier that will guarantee us the meaning and fix our symbolic identity forever. It is this lack of the signifier or final word that marks a 'hole' or a lack in the symbolic order. As I have discussed in Chapter 2, this 'hole' in the symbolic order marks the 'unthinkable' space: the place where gains and losses, emergences and losses, nature and

culture coincide. For example, in as much as the kernel of the Real is jouissance (enjoyment), this *jouissance* is impossible or prohibited by language (by this hole). Yet it is this prohibition itself which produces a surplus enjoyment embodied in the *objet petit a* (the object cause of desire). Another way of looking at this is to think of difference between *jouissance* and surplus enjoyment as the difference between the animal-instinctual enjoyment and enjoyment based on desire when human being is caught up in language.[5] It is also this 'hole' in the symbolic order that is contingently entangled with the body, the result of which are the human 'drives'. It is helpful to think of the subject as the being-in-language in terms of the relationship of desire and drive to the symbolic order:

> Desire is essentially linked to the law, since it always seeks out something that is prohibited or unavailable. The logic of desire would be: "It is prohibited to do this, but for that very reason I will do it." Drive in contrast, does not care about prohibition: It is not concerned with overcoming the law. Drive's logic is: "I do not want to do this, I am nonetheless doing it." (Salecl, 1997, p. 19)

And it is the *objet petit a,* that mediates between desire and drive. Thus desire always remains unsatisfied moving from one object to another by posing limits and prohibitions, drive always finds satisfaction by endlessly going around the *objet petit a*, which produces that surplus enjoyment. Lastly, we must recall the Lacanian notion of fantasy. The function of fantasy is crucial in the dynamics of symbolic identification. Since the 'I' as the subject of speech is located in the symbolic order– the domain of language and culture– it can never be exactly the self of being. Because of this 'gap' the subject inevitably seeks a substitute to fill this gap. Fantasy is a narrative of this primordial loss. "The fantasy is the stuff of the 'I' that is originally repressed" (Zizek, 1997, p. 65). It is fantasy that guarantees us the coherence and consistency of our reality. The relationship between fantasy and symbolic identification is such that the symbolic identity

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[5] In his interview with von Foerster, Maturana alludes to this distinction in response to von Foerster's observation about how a chimpanzee (Lucy) could learn language and communicate efficiently. According to Maturana even though animals like chimpanzees are able to learn a language they do not enjoy as human being do. (Bunnell, P & Vogl, B (producers), 2000)

(teacher, father) relies on the disavowal of this fantasy or "phantasmic passionate attachments" (Zizek, 1999, p. 266) that serves as its ultimate support.

It is against this background that we must read the student teacher experience in terms of emotions or affect. The subject symbolic identification with Other involves anxiety. Anxiety arises from the subject trying to discern the desire of the Other. That is to say the subject does not know what the Other wants from her, what object (*objet petit a*) she is for the Other. In the same way we might read the student teacher's experience above as an identification with the symbolic Other here epitomized by the students in the class. Thus her question to the students might be like this: "What do you want from me? You are telling me that I am your teacher, what object am I for you?" "What is more in me that makes me worthy of your desire?" Yet the students as the Other does not has the answers because the Other is lacking too, is desiring too. This may arouse anxiety for the student teacher. It is fantasy that allows the student teacher to deal with this anxiety by constructing a narrative that provides for consistency and coherency in her experience. In other words it is fantasy that provides an answer for the question of what the student teacher is for the students.

While we are in this terrain of thoughts it is worth pausing a moment to reflect on what might the pedagogical relation mean in light of teacher-student(s) relationships. From what I have discussed above, the relationship between the (student) teacher and students might be thought of as a relation between the subject and the Other. But this relationship between the subject and the Other hinges on the overlap of the two lacks (lack of the subject and the lack of the other). Put differently, this relationship is related to the 'hole' in the symbolic order opened up by the subject symbolic identification. It follows from this that the teacher-student relationship is not complementary in the sense of a harmonious totality but that which involves the teacher's uncertainty and anxiety arising from the relationship between her desire and the desire of the students[6].

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[6] This relation and the question can be reversed from teacher to student(s) depending on the focus. My focus here is the teacher and identification

That is to say there is no universal formula or harmonious totality guaranteeing this relationship. It is because of this lack of universal formula that fantasy intervenes.

Against this background, we might understand how the student teacher comes to deal with her identification. Fantasy provides her with a schema according to which certain kinds of students can function as objects of her desire filling in the gap in the symbolic order. That is to say, through fantasy the student teacher constructs 'a formula' for her relationship with students or pedagogical relation thereby comes to recognize (desire) only those students who fit her 'formula'. Do we not recognize this formula in the student teacher narrative? How then are we to read the student teacher encounter with the one student? Does it not mean that this student does not fit in the formula? What we should take note here, is that in order for fantasy to be operative it must be repressed, by the student teacher, i.e. not known by the student teacher. It has to maintain a distance from the student teacher's formula sustained by it. That is to say, fantasy functions as an inherent transgression to the law or formula it sustains. We are now in a position to understand the student teacher's frustration of her encounter with the one student. Clearly this student does not fit in the student teacher's 'formula' of the pedagogical relation. In this way we might suggest that the encounter manifests the repressed fantasy that sustains the student teacher's pedagogical relation.

What we should note here is the form of the knowledge related to the student teacher's fantasy. As I have mentioned, in order for fantasy to be operative it must be repressed. This implies that, the subject who is the student teacher in this case cannot be conscious of her fantasy. That is to say, the form of knowledge of fantasy is the unconscious knowledge or the knowledge in the Real. This knowledge cannot be subjectivised. It is knowledge that involves enjoyment.

Maturana articulates the same form of knowledge in the relationship of emotions and rationality. According to Maturana (1988a) our emotions guide moment after moment our doings by specifying the relational domain in which we

operate at any instant, and give to our doings their character as actions. In addition, Maturana notes that we are not fully aware of the emotions under which we choose our different rational arguments. It follows from this that we cannot simply advise the student teacher to give challenges or extra work and expect them to change. In other words, the decision to change by the student teacher will depend on her emotions.

One student told me about his experience of teaching mathematics to college students. As he was teaching he felt that the students understood mathematics well. He became paranoid that these students might know mathematics better than him. When he gave them a test for the first time he was happy to find out that the students' marks were in the "range of what you would expect from a normal class of students". From that moment on the student teacher felt comfortable with his teaching. Here we should note that fantasy is related to being, or in enactivist language fantasy is related to the organism's "organization" [7]. A conclusion to be avoided here is that the students who frustrate the student teachers are those who understand well. What we should take note of is that the student teacher relates to the students in a manner that they fit in her phantasmic constructed formula for the pedagogical relation.

As the student teacher in the following narrative describes her experience with not only bright students but also this other student whom she calls the "queen of no work".

Queen-of-no-work, bright students

> I am experiencing a very broad range of students (from Math 7 students who cannot multiply to Math 31 students who are whizzing through limits). Luckily they are not all in the same class. I am finding it difficult to adjust assignments and homework to meet the needs of both ends of my classes. It sounded so easy in class to just diversify the work to suit the needs of individuals but I am finding

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[7] From psychoanalytic perspective, in so far as we are subjects in language, being is lack of being, Fantasy relates to this lack of being. From enactivist perspective, organization relates to the identity of living thing, that which defines its class.

the reality of managing 30 grade sevens makes it difficult to know them well enough to know what they need.

I have the Queen-of-no-work in my Math 7 class. I am truly astonished at her ability to avoid doing any work. She has a dozen new tactics and excuses for each class. Finally I figured out that she can barely do basic operations. Her work avoidance behaviours are really self-esteem survival skills – you can't fail if you don't get started. She really, truly cannot do the work. Now that I know what is going on I want to help but I do not know where to start. I feel like I am barely keeping up with the class as it is. Theory and practice seem miles apart sometimes. I have few ideas but I don't know how successful I'll be.

I also have two very bright students who want to work ahead as that is what their last teacher allowed them to do. I have no objections to them doing that but it means I really need to get on top of the long-term plans and figure out what they should be doing. I can feel myself getting further behind as I write this. I'd better get back at it. (Student teacher narrative)

There is however a slight difference between this student teacher's experience and the previous one. In the previous narrative the student teacher encounter with the student continued to disturb her in a terrifying way. In the above narrative the student teacher although surprised by the "Queen-of-no-work" articulates what might be the problem with this student. Does it mean that this student teacher has recognised her fantasy or passionate attachments? No. Here we should distinguish the fundamental fantasy "that serves as the ultimate support of the subjects being, and the symbolic identification that is already a symbolic response to the phantasmic passionate attachment" (Zizek, 1999).

From enactivist perspective, this distinction relates to the organisation and structure of an observer (as a living system). The organisation refers to the relations that must exist among the system's components for it to be member of a specific class and its structure refers to the components and relations that actually constitute a particular unity (Maturana & Varela, 1987).

What the student does by articulating the problem with the student is to rearticulate her symbolic identification that leaves intact her fantasy. Or what changes for this student teacher is her structure that preserves her organization. This distinction is crucial for any interventions and the consequences of those interventions as teacher educators we might do to help the student teacher. The

point here is that interventions that involve fantasy or organisation are 'traumatic' as they involve some kind of 'loss' of being or reality.

Classroom Management, Control and the Child

Disciplining

We can't please every single student with what we adopt as our teaching approach, be it in terms of curriculum development or in disciplining. This is something that I'm just beginning to learn to accept.

You see this past Friday afternoon, with my more rambunctious of the two grade seven classes, I was forced to do what I perceived to be a semi unfair thing to do. I gave the whole class a 30-minute DT after school for failing to cooperate after repeated warnings (although I was 'nice' enough to give some the option of writing a 2-page explanation of their behaviour). Admittedly, some of them were not guilty, but sometimes in life, that seems to be how things work.

With this particular class, I've had to change my management strategy 3 times. In the couple of times I was trying to be Mr. Nice to them. You can understand my wish to not make too many enemies on the first day. But a BIG (that's why the capital letters) mistake on my part. Though I did succeed in not making any enemies, I failed to make them see that I am not like one of their friends that they could 'mess' around with.

After a talk with my cooperating teachers, I went home and came up with a "harsher" plan (apparently not hash enough, as I was soon to see). Using the recent O.J. Simpson trial as an example, I "lectured" them on the classroom is like a courtroom, and I'm the judge on duty. I expressed my desire to have "order in the court" (a phrase which I wrote in big letters on a piece of cardboard that I was to use a few times in the next couple of days), so that my proceedings (i.e. my trying to teach and their need to learn) would not be interrupted. Perhaps it was because many of them had watched the trial that they quickly adopted this approach.

They came the Family Day - long weekend. On Tuesday, they showed up as if it was their first day in junior high. And their behavior was indicative of their elementary-school-day behavior. Half of them actually expressed the wish that I treat them as kids, rather than young adults, if you can believe it!

So another lecture followed, this time a bit longer. This time, I came up with the hockey in the classroom scheme. The analogy goes something like this: I'm the referee, they are the players. As much as some players don't like the rules, they are part of the game of hockey. I decided to give them a say in coming up with these rules (call it collective bargaining), so that they might be mutually agreed upon rather than impose on.

I had the better of the 2 classes first. And we spend about 15 minutes discussing the 3 rules that I had come up with, and they were:

Slashing (misuse of stick in hockey, but misuse of tongue in the classroom, i.e. speaking out of turn or rudely) Penalty: 5 minutes of extra ice-time after school. Delay of game (self-explanatory—wasting time, not settling down immediately) Penalty: varies depending on the amount of time wasted.

Unsportsmanlike conduct (again, self-explanatory—fooling around in the classroom) Penalty: 15 minutes.

The kids found these rules interesting, probably because many of them are die-hard hockey fanatics. One even showed me the hand signals for them. See how teachers can learn from their students!

With the other class, however, these rules created instant controversy. No surprise there! Some made the excuse that these rules stink because they don't like hockey. Most complained that the penalties were too harsh. They went on to argue that, for this analogy to be 'perfect', I should reduce the penalty minutes to a standard 2 or five minutes. I didn't give in to their demands, but I did make a deal with them. If they didn't want to serve their penalty, then they could write me poetry, the number of lines corresponding to the number of minutes that have to be served. OR else they could pay me 10 cents per minute to be served.

That worked for a couple of days until last Friday, when once more this class experienced a sudden amnesia. I tried to give them a break by playing a game with them, but they refused to cooperate with me and with each other. So I eventually commanded them to sit down and be quiet for the remainder of the period, and imposed that a 30 minutes DT on the whole class.

As I said before, I felt quite guilty afterward, but over the last couple of days, I can see that some students a finally getting my message. Some of them, I think, have changed their minds about me. I'm not surprised if some of them hate my guts. But this morning, in talking with my cooperating teacher, I was reassured that this is a good thing.

Two weeks ago when I started, I certainly couldn't see myself as being as tough as I am now. I don't think I've turned my class into a military boot camp. At the same time, I'm thinking. Can a little bit of military-style classroom management really be that bad? After all, didn't Danny Devito in "The Renaissance Man" play a teacher who could easily be me or you? And look how his students turned out at the end? (Student teacher narrative)

The question of classroom management and control in education is an old one. Anyone who has been involved with teacher education at some level will not be surprised by the above student teacher's experience. Classroom management issues permeate most conversations among student teachers, cooperating teachers and supervisors during student teaching. Johnson (1994) identifies three student teacher's conceptions of classroom control:

1. Rule-based conceptions are consistent with the findings of research on the management practices of effective teachers. Emphasis is placed on the importance of establishing and consistently enforcing class rules; well-planned, well-paced lessons; and monitoring student behavior to prevent misbehaviour from occurring. The holding of such conceptions does not prevent a teacher from being warm and caring; however, the primary emphasis is on rules, monitoring, and lesson involvement.

2. Dominance conceptions emphasize the personal power and authority of teachers through displays of power, demanding students to listen, starting out strict, and the use of punishments to keep students behaving well. Such conceptions place much emphasis on rules and less emphasis on lessons and instruction. Instead, teachers try to command respect through forceful directions and fear.

3. Nurturance conceptions emphasize the importance of warm, friendly personal relationships between teacher and students. Such conceptions focus on fun lessons and letting students decide, at the expense of classroom order. They give less emphasis than rule-based conceptions to rules and lessons and more emphasis to gaining the students' liking as a means of eliminating misbehaviour. (Johnson, 1994, p. 111)

Reading the student teacher narrative above we can see how the student

teacher struggles with these various identifications. To set up rules he uses a number of analogies from the court, hockey and military. We can also see how he struggles between nurturing (caring and guilty of including students who are not supposed to be punished) and setting up rules. As the student teacher's narrative attest, contrary to the stage theory, classroom management and control is not just a problem with student teachers, but also for practicing teachers. This is attested to by movies and stories portraying heroic teachers who succeed managing very extreme problems of classroom management such as the movie "Stand and Deliver'. One might risk generalizing that classroom management and control is part and parcel of teaching. Why is classroom management and control such a concern in education?

Britzman, (1991) explains this concern with classroom management and control in education as that which is a result of the teaching myth "everything depends on the teacher" that student teacher come to position themselves. Britzman identifies two rules governing the cultural tensions of education: "unless the teacher established control, there will be no learning, and if the teacher does not control the students, the students will control the teacher" (p. 223). Against these rules learning is constructed as synonymous with control. In addition to this, classroom control comes to be recognized as one of the teacher's competences.

In the field of mathematics education itself, some researchers have found out that classroom control influences the kind of methods the teacher might use. McDougall (1997) reports that classroom teachers may initially experience a loss of control when using new exploratory learning environments. Is classroom management and control just that? I want to suggest that there is more to the question of classroom management and control. To lead us to this point, let us consider one of my conversations with one student teacher after I had observed him teaching. During this class the student teacher gave the students a problem that they were not able to solve. According to the student teacher the students were supposed to solve this problem with ease because they had done the same problem before only with different numbers. He continued:

I teach two math classes of form 4. This class (4R), and the other one (4S). When I compare these two classes I am surprised by the differences between these classes in terms of understanding math. Students in this class are generally quiet and attentive when you teach as you saw. You naturally get a feeling that they understand what you are explaining. But when you give them problems to solve, most of them are unable to solve them. Students in the other class are bit noisy but they do well in math. (Student teacher narrative, Tanzania)

I also observed the student teacher with the other class (4S). It is interesting to note that the noise the student teacher complained from this class was actually from students discussing among themselves about what the teacher was teaching. What interests me about this conversation is the following. First, from my observation, there was really no problem of noise. Second, student teacher's expectations regarding the relation of silence in the classroom and students understanding or learning of mathematics: students being quiet in the class suggest that they understand what the teacher is teaching, whereas a noisy class suggests that students are not getting what the teacher is teaching. Against these expectations, we must resist the temptation of reading this apparent 'unnecessary' student teacher's concern on control, as just a (mis)conception or belief obtained from his schooling experiences, that the teacher has to show classroom control. In the same token, we must also resist reading this experience as the student teacher's appropriation of the teaching myth (even though informative) as Britzman (1991) would put. What if we read this student teacher's concern for classroom control as something necessary? To lead us to this suggestion, let us read the following student narrative.

On being an asshole? Classroom management; problem students

My cooperating teacher has a complete control of all her classes. There is no talking unless she allows it. She could leave the room for 20 min if she wanted to, and still there would be near absolute silence when she comes back.

There is no rudeness, and complete manners are demanded of the students. No one answers huh, or yah, or what, it is all yes and pardon me. Kathy is an older lady I would guess upper 50s or lower 60s. I wasn't sure how she did it, but from what she tells me she spends the first couple of months as

the worst bitch in the world. She lets absolutely nothing go, and she teaches manners all the time.

This might sound totalitarian to us, but you wouldn't believe how many parents enjoy that she is like this with her students. You might also think that all the students hate her, but she constantly gets visits from old students. And from what I can tell even though the students we have now pretend they are scared of her. I can tell that this mostly joking around.

Last week I had a couple problem students and a little bit of noise problem with some of my classes. Not really bad, by my standards but by hers unacceptable. And as we all know even though we are out here to get experience it is still not our classes, we can change things but we should not totally destroy what our teachers have been accomplishing.

So on Wednesday we had a talk, and she asked me what we were going to do about our noisy problem students. I really had no idea, and she gave me this advice. We have to demand respect from our students, they are not our equals, we are adults and they are students; there has to be a separation between us. Our job is to teach not to make friends we have our own friends we do not need a bunch of twelve-year olds as friends. She also told me that for the first months she is the biggest bitch in the world –her words- and then you can let off. Once you have the ground rules established you can let off, you can even joke around with them, but they have to know that when you say stop they stop.

She also told me that if she can teach me anything while I am out here is to be an asshole. She said that I probably know more Math than her and could do circles, but without classroom management, you are just setting up for failure as a teacher. She said that she never has a bad day at school, and this is because of management, without it there is only stress, and this is why so many teachers now go out on stress leave, or just quit.

Sound advice, however that night I thought about it so much that I took it into my sleep and had nightmares about trying to be an asshole, and the kids rebelling. It was so stupid and hard and when I got up I seriously doubted that I could really be an asshole, I like being on the good side of the kids. (Student teacher narrative)

Already in this student teacher narrative we can see that classroom management is not just a student teacher's concern. The cooperating teacher in this narrative takes classroom management as a necessary requirement for someone to be successful as a teacher. What is striking from this narrative is the extreme

measure this cooperating teacher takes beforehand to ensure this control and management. The student teacher notes this extremism by alluding to totalitarianism. Here we might wonder as the student teacher wonders how students come to obey and live with these demands. In fact as the student teacher notes, students seem to enjoy this. Do we not again notice the logic of emotions, affect and enjoyment as I have mentioned above? The prohibiting of some kind of *jouissance* (here epitomized by students misbehaving, noise and so on) produces an object of desire (*objet petit a*) that embodies surplus enjoyment. In other words the fact that something is prohibited creates a phantasmic background supported by the *objet petit a*. That is to say the discipline measures by which the students are subjected in the above narrative become invested with this surplus enjoyment (which may be pleasure in pain) and students enjoy.

This, however, should not mean that students cannot resist these disciplinary measures. Here again we must distinguish resistance involving symbolic re-articulations or structural changes and resistance 'proper' involving confronting or traversing one's fantasy, emotions or organization. To resist in this case might mean to undo the social relationship itself and begin anew.

The question still remains why student teachers or teachers are concerned with classroom management and control. It is in the last paragraph of the student narrative that we find the guide for the answer: "Sound advice, however that night I thought about it so much that I took it into my sleep and had nightmares about trying to be an asshole, and the kids rebelling". It is this encounter with kids rebelling that we must look for the answer. It is here that we must follow Jardine's interpretative project of student teaching:

> In particular, I am interested in weaving an interpretive tale of how the child functions as a monster for a beginning teacher and how the demonstrations of the child's questions can teach us the lesson in the very act that we teach them. (Jardine, 1998, p.125)

And what is the monster if not that figure in mythology and literature that is invested with different sorts of emotions: fear, wild and so on.

The notion of the child as a monster does not apply to student teachers only but to teachers, educators and researchers in education. It is almost a common place to find that conversations involving the child or student dominate among teachers especially in staff rooms and staff meetings. Here we should avoid the temptation to explain away this observation by justifying the dominance of the child in teachers' conversations as an obvious outcome of the fact that we teach children or students. After all they are at the centre of education. While there is some truth in this observation, it does not address the monstrosity of the child or the students: the fact that we are sometimes fearful of the students, or we find them wild in need of management or control and so forth. How then are we to explain this concern of the child as a monster?

We approach this question through the notion of *objet petit a*, that which the teacher looks for, in her students in order, to fully assume her identity as a teacher. We recall that the *objet petit a,* emerges (as lost) at a point where identification fails between the subject (teacher) and the Other (the field of meaning), at that space where the two lacks (of the subject and the Other) overlap. It follows that the *objet petit a* is the subject's object correlative that embodies his or her radical otherness. It is this *objet petit a* that the teacher looks for in the student. In other words, it is as if that something about the student prevents the teacher to realize her full identification. Put differently, it is as if the student prevents the pedagogical relation to be realized in a complementary harmonious way. Perceived this way the student is an obstacle for the realization of this pedagogical relation. The student is a monster that prevents us (teachers) from passing through to the other world, to fully assume the world of meaning (what does it mean to be a teacher). In this way the student comes to embody that surplus enjoyment resulting from this prohibition.

This explains why for teachers, students need to be controlled, managed. In addition this explains why the characteristics of students condense opposing qualities (negative and positive): they are noisy but also quiet, interested and not interested in learning, and so on. They are either too much or much less the qualities we would wish them to have. The following student teacher narratives

reveals how student teachers struggle with this logic to find the student as just what teachers would like them to be.

We cannot please everyone

You will never please everyone all of the time. I think that we'll be lucky to please any of them most of the time. All you can do is try your best.

I think the problem lies in a lack of interest in mathematics material. How do you make math fun for everyone? I like your idea for integers and lining the students up. I like that you made it their responsibility to get things done. I hope you don't mind if I steal this idea. Part of the unit I'm teaching is on patterns and I think I may be able to get them to see how things work a little better if I make what we are working with a little more hands-on.

Classroom management seems to be the toughest part of teaching at the junior high level. How far do you let them go? You don't want a military like atmosphere in your classroom, but how do you find the middle ground between that and total chaos? (Student teacher narrative)

Interested ones

The class I taught today was the introduction to coordinate geometry to math 13 students. I read Dave's message, but sorry I can't really help you out because my math 13's are very motivated, and suprisingly are quite interested in Math, so they don't seem to get time to get very rowdy. They do like to chatter sometimes, but I've found that they are usually talking and doing work at the same time. In talking to my teachers, they have said that Math 13 and Math 23 classes need to be given some leeway in terms of strict rules in the classroom. They just don't work well under conditions of no talking, only working. They said that these students are looking for conversation and interesting math- so that's what we need to give them. Once they get off task for a long time, pull them back into focus, but don't be too stern – these are the words of wisdom I have received. My favourite classes right now are the Math 13 and Math 23 classes I have – they are a hoot. In teaching midpoint to Math 13 today I told them some Math puns and they actually laughed and wanted more. (Student teacher narrative)

Reading these two narratives we can see how this function of the child as monster works. When we expect students to behave in a certain way that is

when they surprise us by behaving otherwise. There is no 'formula' for this. The child is that figure at the unthinkable space (Cohen & Varela, 2000) of pedagogical relation. In order to understand more about the notion of the child as 'monster' let us see what happens when there is no need for management and control?

When there is no need for management

When I first observed the classes I would be teaching, I could not believe how well behaved and cooperative they were! My initial thoughts were wow, and great, I won't have to spend every second making sure they behave. However, I have found these classes to have certain downfalls.

At first, the students would just sit there and listen to the lessons without getting involved even though I tried many different things to get them involved. It is very disconcerting to have 30 sets of eyes watching you without any interaction on their part. Now they have started to loosen up, but they are also misbehaving.

The main problem is that I find myself not being as I was last year and perhaps being a little too lax with the discipline. I wanted to experience a different angle of teaching, one where the students cooperated with you. I have that to a large extent, but what I am realizing is that I still have to be the person who controls the order in the classroom. So what am I doing this weekend? I am making a list of the discipline problems I have encountered so far and what my responses have been to them. Then I am going to look for new solutions that I can experiment with this coming week. What I am trying to do is find myself as a teacher. I know that sounds a bit weird, especially at this point in our schooling, but I am still attempting to find my own 'teacher' personality. (Student teacher narrative)

Do we not see this interplay of student teacher identification and the monstrosity of the students? Herein lies the truth at the end of the narrative: "What I am trying to do is to find myself as a teacher. I know that sounds a bit weird, especially at this point in our schooling, but I am still attempting to find my own 'teacher' personality." We might advise this student teacher that there is nothing weird with attempting to find the teacher personality because it is actually these attempts that engage her in the teaching.

What happens then when there no need for management? "It is very disconcerting to have 30 sets of eyes watching you without any interaction on their part." Herein lies the logic of this *objet petit a*: that is more in the teacher, a part of 'being' that is lost in symbolic identification. When there is no need for control, it implies that the teacher comes close to the *objet petit a.* And what is this object if not the teacher himself or herself in his/her radical difference. That is to say coming close to it is like facing yourself in your radical otherness. This is terrifying or disturbing as the student teacher notes. In addition, the *objet petit a,* is the object of fantasy. Therefore coming close to it is like confronting one's fantasy that must remain repressed in order to have coherency and consistency of one's experience. Confronting one's fantasy therefore is loosing what sustains the coherency and consistency of one's experience. That is why this is disturbing. The following student teacher narrative explains more of this encounter with the object or fantasy.

> I will never forget the experience I had with this one class of Form 2s. It was my first time teaching this class. I taught logarithms. Before teaching I had prepared my lesson very well. I even discussed my plan with my cooperating teacher. She was happy with my lesson plan. When I entered the class, students were very quiet. I introduced myself and started teaching. In between lesson segments I stopped and asked students if they understood what I was teaching or if they had any questions. Nobody responded. At the end of the lesson I asked them questions to see if they understood the lesson. Again nobody raised her hand. This was very frustrating. At some points I decided to pick a student randomly. To my surprise some students did answer my questions correctly. Why didn't they raise their hands? I wondered if this was some kind of arrogance or they were not sure of their answers. I was really frustrated in this class. I felt like I was alone in the class. I was very lonely. (Student teacher narrative)

Do we not see here this extreme experience of 'no need for control'? Therein lies the experience of the encounter with the *objet petit a* an embodiment of one's radical otherness. This relationship between student teacher and the students is not confined to noisy or no noisy classes. We can see this in some pedagogical decision in the teaching of mathematics as the following narratives show.

The Answer

Answers at the back of the book

We all seem to agree that there is a need to stress the importance of procedure and method as opposed to the answer. During the school project, I assigned some questions out of the text for seatwork. I was teaching 12 students so I was not able to watch them all the time. I circulated and helped those students with questions. It didn't take me too long to realize that a majority of students were copying answers straight from the book. I addressed this and kept an eye on the students but what do you think they did at home? Now when you are reducing fractions or ratios there isn't a lot of work to show so...

Yesterday I met with my cooperating teacher and she had had the same problem. Her solution: she called in all the texts and cut the answers out of the book. Do you think having the answers in the back of the book is a problem? (Student teacher narrative)

Just like the student teacher notes in this narrative, the question of the answer is an important one in mathematics education. It is a commonplace now in mathematics education projects especially those based on reform movements to de-emphasize the role of the answer in the learning of mathematics. Teachers are asked to focus more on the methods by which students solve problems than the final answer. Read against this background, the experience of this student teacher in the narrative lies within the expected pedagogical decisions in terms of de-emphasizing the role of the answer in students solving mathematics problems.

Yet again this reading misses what is passed on silently with the question of answers in this narrative. Here we have the student teacher assigning questions from the book whose answers are provided at the back of the book. He notices that some students are not solving the problems but coping answers from the book. In order to discourage the students from mere coping answers from the book the cooperating teacher cuts the pages containing answers from the book. The question to be asked here is this: does removing answers from the book de-emphasize the value of the answer to the students? Do we not see the

logic of prohibition and fantasy looming around this practice? Is it not removing the answers from the book and therefore prohibiting the students' access to them the very reverse of de-emphasizing answers? Students come to value even more, answers than procedures or methods. Let us now read the following narrative from another student teacher.

> In regards to students having access to the answers to their assigned work I just wanted to make a couple of observations. I have two co-operating teachers who handle the issue in completely opposite ways. One has the answers in the back of the book for daily for daily assignments. He quickly goes over any difficulties in class but does not mark daily work unless he feels like the students are not doing it. Near the end of a unit he gives a worksheet for review and collects and marks it. My other cooperating teacher has cut the answers out the back of the books and marks the assigned homework everyday. She usually assigns only half of questions in the text. If students get below 50% on the assignment they must make corrections or she allows them to have a totally new assignment (from the other half of the questions). Last week the entire group did very poorly on an assignment and they were given a new assignment. Most of the students have completed the entire assignment by switching the x's and y's in their calculations of slope. On the second assignment they seemed to have learned from their mistakes.
>
> I think that there are some more subtle, philosophical undercurrents here as well. How do we teachers teach our students to be responsible for their learning—to use the answers in the back to help themselves and not just to get out of learning the material? What age and stage of development is it reasonable to expect behavior which ultimately serves themselves in the long run and not just lets them off the hook in the short run? How do we as teachers adequately monitor attitude as well as homework?

Already in the student teacher's remarks in the last paragraph of the narrative, we can see how the question of answer is 'undecidable' in mathematics teaching. Removing answers or as matter of fact using any other measure to prohibit students from access to answers, does raise a question for students' responsibility for this student teacher. Is it the responsibility of the students that is at stake here or is there something more related to the role of the answer in mathematics teaching? What is the role of the answer in the pedagogical relation? During our conversation, one student teacher observed that most of the

mathematics teachers in the school where he was teaching do not like to teach the topic of congruence and similarities. When I asked him, why he thought that was the case, he continued:

> What I have noticed when I teach this topic students do not understand well. When you show them how to prove the theorems, they don't understand. When you reach the end of your proof students ask, "So what did you prove here? How did you know that the sum of interior angles in a triangle is 180 degrees? I guess for these students as long as there is nothing like a final answer they do not understand what proving theorems means.

Related to the question of the answer is the question of mental calculation and the calculator as the following student teacher narrative show.

Calculator or Mental Calculation

Calculator dependence

> I am amazed at the dependency students place on their calculators. I am teaching Math 10, 24, 33, and 30. You would think that with this wide range of ability, that some students would be more attached to their calculators and other would not. This on the whole is not just not true. The one clear similarity between all of these levels, is that they all need their calculators to do mental math.
>
> I think it stems of uncertainty. I think the majority of them are obviously capable of doing arithmetic mentally, but its like they need to be sure. So they use the calculator. Afterall, they paid enough money for them, why not use them?
>
> This use of the calculator is seen in every math class. And it is unfortunate, but its really unavoidable. As long as school boards dictate the early use of calculators, students will continue to use them for all operations. Its only a matter of time, that we start seeing them in early elementary. (Student teacher narrative)

Here again we must read the question of mental calculations and calculators against the pedagogical relation. We must try to read what is more to the teacher's need for students' mental calculations as opposed to the use of calculator. For example, why does this student teacher fear the use of calculator in elementary school? We should note that this question does not mean that the

concern for use of the calculators is unwarranted, as the following student narrative will show. Rather, the focus is to locate where this need seems to be without grounds, habituated and so on. It is here that we must focus our attention in order to turn this seemingly unnecessary need into a question about that which is inherent to the nature of the pedagogical relation.

I just finished teaching factoring trinomials of the type $Ax^2 + Bx + C$ in Math 23, where I had noticed an incredible range in student ability, so I decided to teach three different methods. The book's method is to find the factors of A*C that add up to B, say p and q, then write the equation as $Ax^2 + px + qx + C$, and factor that by grouping. Though this is a tad tedious, the students without strong mental math abilities can do it well and quickly. The grid that the instructor showed us requires more mental ability to try out the possibilities, but keeps it fairly well organized for those that loose track of what they are doing. The puzzle method of trying the different options till finding one that works (that most of us would use) will only make sense and work for those that can quickly compute simple addition and multiplication in their heads and then organize the material well enough to put it in answer form.

When I taught this, I encouraged them to experiment with each one and to use the one they felt most comfortable with, expressly stating that the last method is by far the fastest, but requires good mental math skills. What I found, is by the end of the first period where many students used one of the first two methods, they all recognized the power in being able to do most of the work in your head. Because they were working in pairs and groups, many of the more math minded students automatically helped others figure out the faster method, encouraging and helping them to make any simple calculations mentally.

All that to say this – when I gave them a choice of how to figure something out, where one of the methods was more efficient but used a lot of mental calculations, they motivated and helped each other to use and improve their ability to calculate mentally, just so their job would be easier in the long run.

I don't know, but may be if there is a way of inspiring a need or desire to calculate in ones head, they might be motivated to do it more often. I haven't thought about how one could do that in other areas or grade levels of math- any ideas? (Student teacher narrative)

Even though it might seem that there is a need for the students to use their mental calculations in this narrative, we can still see the excess for this need in the last paragraph. The student teacher notes that students must be inspired in

order to have the desire to calculate in their heads. Herein lies the unnecessary need for student to use their mental calculations.

So these are the experiences of student teachers in their teaching practice. I have attempted to read their narratives in a manner that provides a pedagogical space for us to learn about our practice as teacher educators. My reading focused on the function of affect and emotions, as understood in enactivist and psychoanalytic perspectives. In addition, I have attempted to read these narratives in the context of pedagogical relation. Hence, I have highlighted the dynamics of the 'unthinkable' space of the pedagogical relation. Given this background, how might we understand knowledge and pedagogical content knowledge in teacher education? The next chapter discusses the question of knowledge and pedagogical content knowledge.

Chapter 5

CONTENT– PEDAGOGY KNOWLEDGE

> If you give me a quadratic equation, any form of a quadratic equation, I know how
> to solve it. Yet when I think of teaching my students how to solve a quadratic
> equation, I don't know how I can do that. How can I stand in front of the class and
> teach quadratic equations? (Student teacher narrative)

Reading the above student teacher narrative might evoke a number of reactions. A commonsensical reading might lead one to wonder: If this student teacher knows how to solve quadratic equations himself, how is it then that he finds it difficult to teach this to his students? Following this question a number of reasons for this student teacher's experience, such as a lack of confidence on the part of the student teacher to stand in front of a class, might be given. In this way, one might suggest that what the student teacher needs is some 'how to' suggestions that might help him to gain confidence. Yet this reading misses what is at the heart of the student teacher's concern: How does one teach a particular subject like mathematics? Embedded in this question and the narrative itself is the question of the status of knowledge and its relation to the status of teaching and learning. In fact, these questions are already hinted in the ponderings above: if this student teacher knows how to solve quadratic equations and yet finds it difficult to know how to teach it, what is this knowledge of how to solve quadratic equations?

In the context of knowledge in teacher education these questions and student teachers' concerns raise the problem of the nature of pedagogical content knowledge. Rather than pedagogical content knowledge, I have chosen to use content-pedagogy knowledge. This is because I want to highlight and call our attention to what is at stake in the student teacher's concern: the space between content and pedagogy. This space indicated by hyphenation in content-pedagogy points to the dynamics of the teaching of a particular subject such as mathematics. Bernstein (1996) elaborates well the nature of this space when he talks about pedagogic discourse:

Pedagogic discourse is a principle for circulation and reordering of discourse ... for delocating a discourse, for relocating it, for refocusing it, according to its own principle.

Now in this process of delocating a discourse (manual, mental, expressive), that is, taking a discourse from its original site of effectiveness and moving it to a pedagogic site, a gap or rather a space is created.

As the discourse moves from its original site to its new positioning as pedagogic discourse, a transformation takes place. The transformation takes place because every time a discourse moves from one position to another, there is a space in which ideology can play. No discourse ever moves without ideology at play. As this discourse moves, it is ideologically transformed; it is not the same discourse any longer. I will suggest that as this discourse moves, it is transformed from an actual discourse, from unmediated discourse to an imaginary discourse. As pedagogic discourse appropriates various discourses, unmediated discourses are transformed into mediated virtual or imaginary discourses. From this point of view, pedagogic discourse selectively creates imaginary subjects. (p. 47)

However, there are some differences between Bernstein's formulations and focus on the space (or gap) and what I perceive it to be in my discussion. Bernstein's focus is on the structure of the pedagogic discourse. My focus is on the pedagogical relation of pedagogic discourse, one in which the teacher and students are embedded. In addition, in so far as the human being is a being-in-language, discourse as a human system is also in language. From a psychoanalytic perspective, discourse "might be thought as a relation of signifiers, an ordering" (Davis, 2000, p. 3). In this way, when Bernstein asserts that a pedagogical discourse is a "discourse that moves", it is not the discourse that moves but the signifiers that are selected.

In this chapter, I bring forth what I have discussed from the previous chapters thus far. The chapter might be thought of as a construction as opposed to an interpretation, in the sense in which it is understood from a psychoanalytic

perspective. In other words, this chapter might be read as a logical construction of events that might or might not have happened, nevertheless has the potential to have a pedagogical effect on the reader.

My presentation begins with a discussion on how we might understand mathematics as a human system, a discourse in language. Next, from the enactivist and psychoanalytic perspective, I discuss how knowledge might be understood, when it is a question of social relation, such as that between the teacher and students (pedagogical relation). Building on the discussion presented in these two sections, I discuss the central question in this chapter: content-pedagogy knowledge. This is presented in three sections: how content-pedagogy knowledge might be understood in terms of knowledge and ignorance; students as knowers; and finally pedagogical ignorance.

The Discourse of Mathematics

Engaging with issues of teaching and learning of a particular subject raises the question of the nature of knowledge of that subject area. According to Davis (2000), there is an impasse in curriculum theory that revolves around the central antagonism between the Universal and the Particular whenever the question of the nature of knowledge is raised. This antagonism is constitutive of the (re)production of knowledge, and is manifested in oppositions such as subjective/objective, nature/culture, knowledge/knower and so on. In mathematics education this Universal/Particular dialectic is shown in discussions involving oppositions such as: students' experiences vs. mathematics curriculum, everyday mathematics vs. mathematics, informal vs. formal mathematics etc.

In the field of mathematics the antagonism, Universal/Particular is depicted in the debates around the question of the nature of mathematics knowledge. For example, Rotman (1993) identifies two perspectives: one stems from Plato and the other, namely intuitionism, which rejects the Platonist view. Rotman summarizes the Platonist framework as follows:

Thus, within this horizon, there is first ontology and being, the inventory of the objects that are or must be in this already given world; then reference, pointing, and naming whereby language, in an activity external to and after the facts of this world picks out these pre-existent objects; from reference comes sense, the description and meaning of the properties and states of affairs enjoyed by these objects; finally epistemology, the examination of the means of knowing, believing, validating which among the assertions generated by language about these objects is a justifiably "true" description of the states of affairs they take part in. (p. 20)

Rotman further notes that "the order of events, being, referring, meaning, knowing is a crucial element in the way this framework of what constitutes knowledge works to bolster the metaphysics of Platonism. The intuitionist program rejects this classical logic and insists that mathematics is an activity of making mental constructions (Rotman, 1993).

In mathematics education the Platonist perspective is manifested in the traditional perspective on the teaching and learning of mathematics. From this perspective, mathematics knowledge is taken to exist objectively, independent of the knower, context or culture. Teaching involves transmitting this objective knowledge to the learners. The intuitionist perspective is closely related to constructivist perspective in which mathematics knowledge is taken to be individual constructions of mathematics concepts from her/his experience.

There are other debates or discussions in mathematics and mathematics education regarding the nature of mathematics knowledge, its teaching and learning. However, at this point, as the reader might be familiar with the approach I am taking in this dissertation we must transpose what seems to be an epistemological obstacle to an ontological limitation. That is to say we must take the proliferation of perspectives on the nature of mathematics as a reflection of the limitation of knowledge itself. Maturana (1988b) puts this succinctly:

Our incapacity to experientially distinguish between what we socially call illusion, hallucination or perception, is constitutive in us as living systems, and is not a limitation of our present state of knowledge. (p. 38)

That is to say, as human beings operating in language, we cannot stand at a neutral place that will allow us to distinguish between what is illusion or perception in our reality. This, however, is not because of limitation of what we know at present, but rather the limitation is internal and constitutive in us as subjects in language. In addition, as human beings operating in language, we bring forth entities, things, objects, and concepts through our explanations of our experiences in language. "Without observers nothing exists, and with observers everything that exists, exists in explanations" (Maturana, 1988b, p. 33).

It follows from this that mathematics cannot be anything other than a system that we bring forth through explanations of our experiences in language. Mathematics is a discourse in language, and like any other discourse, it is an order of signifiers or a relation of signifiers. Conceived this way, from a psychoanalytic perspective, mathematics pedagogic discourse might be understood as a field of meaning that relies on a phantasmatic background. Hence, teaching and learning of mathematics involves the dynamics of subject's identifications as discussed in Chapter 2.

Rotman (1993) coming from semiotic perspectives provides an example of thinking about mathematics as discourse in language. He offers a model that depicts mathematical reasoning as consisting of thought experiments played out through written signs. These are organized in terms of three figures (semiotic agencies) that operate simultaneously at different levels of discourse.

There is the reader/writer of proper - rigorous and formally correct - mathematical texts, the mathematical *Subject* who uses the Code but has no access to any (necessarily indexical) description of itself. In this, the Subject is an agency entirely separate from the *Person* - the one who speaks informal mathematics and has full immersion in history and the cultural subjectivity coded by the "I" of natural language that permeates the metaCode. The Subject responds only to inclusive imperatives, those of the form "let us consider, prove define x", which ask that speaker and hearer set up a shared world or a world having been set up, share an

activity about it. All other imperatives such as "count the elements of M", "reverse all arrows in D", "integrate f", "add p and q" are exclusive: they demand that certain actions in these shared worlds be performed. Such actions are not carried out by the Subject. Instead the Subject imagines into being an idealized simulacrum of itself as its surrogate, what C.S. Peirce call "skeleton diagram of the self", which executes exclusive imperatives of the form "count", "integrate", and so on. I call this skeleton of the Subject the Subject's *Agent*. Basically, the Subject engages entirely with signs at the level of the Code, the Person with the signs and metasigns of the metaCode and the Agent, an automaton without the ability to engage with any meanings, operates only with signifiers at sub-Coded level. Operating together they enact a single thought- experimental narrative. (p. 84)

For Rotman the thought experimental model allows us to read mathematics as the business of making certain kinds of "rigorous fantasies" or waking dreams. The imagining Subject corresponds to the dreamer dreaming the dream, the skeleton Agent to the imago, the figure being dreamed, and the Person to the dreamer awake in the conscious subjectivity of language telling the dream. Such dreams are persuasive fictions only when (from inside language) we recognize the imago as resembling our imagining selves. One is tempted to read Rotman's three figures as corresponding to the Lacanian three registers: Symbolic, Imaginary and the Real. But this line of thought is beyond the scope of this discussion. I offer Rotman's semiotic approach as an example of conceiving mathematics as a discourse. Let us now move on the discussion of the status of knowledge in human beings.

Knowledge and Human Being

In his seminar *Encore*, Lacan (1998) offers valuable contributions on how we might think of the status of knowledge in human beings. Lacan notes that the status of knowledge must be explained from the fact that the human being is the

subject of language. Lacan notes that as far as the human subject is concerned, language serves purposes that are different from communication or merely communicating information. "Language affects us first of all by everything it brings with it by way of effects that are affects" (p. 140).

To highlight this difference, Lacan describes a scientific experiment in which it is investigated whether a rat can learn about anything. The experiment is designed in such a way that a maze for the rat is set up. The maze leads not only to the food but also to a button or flap that the rat must figure out how to use in order to obtain food. If after some time the number of trials and errors diminishes sufficiently, then it is noted that the rat is capable of learning about something. Lacan notes that the only thing the rat learns in this experiment is to give a sign, a sign of its presence as a unit: the flap is recognized only by a sign and pressing its paw on this sign is a sign. It is by giving a sign in this way that one concludes that there is learning. According to Lacan, to explain the relation between the status of knowledge and status of learning in this way relies on the assumption that language is a system of communicating information. Otherwise, if the status of knowledge in human beings is to be accounted, "we must examine the maze experiment in terms of how the rat responds to what has been thought up by the experimenter not on the basis of nothing but on the basis of language" (p. 141). Failure to do so leaves open the question of the relationship of knowledge to the learning.

For Lacan, the status of knowledge for human beings raises another question, that of how it is taught. This brings us to the question of social relationship or human relationship. As I have discussed before, social relation in a Lacanian sense is not to be taken in a complementary harmonious way. Therefore the only way human beings can relate to through knowledge is through the *objet petit a*.

The world, the world of being, full of knowledge, is but a dream. A dream of the body insofar as it speaks, for there is no such thing as a knowing subject. --There are subjects who give themselves correlates in [*objet petit*

a], correlates of enjoying speech qua jouissance of speech. (Lacan, 1998, p.126)

Further, Lacan notes that as a subject in language, a human being relates to knowledge by way of master signifier, a signifier that represents the subject for another signifier.

Maturana (1988b) differentiates cognition for human beings as living things that operate in language and other livings that do not operate in language[8]. For living things that do not operate in language there are no objects; objects are not part of their cognitive domain. It is only in language that objects may arise. According to Maturana (1988b), for human beings, language is both a domain of existence and a cognitive domain:

Human beings as living systems operating in language constitute observing and become observers, by bringing forth objects as primary consensual coordination of actions distinguished through secondary consensual coordinations of actions in a process that obscures the actions that they coordinate. (p. 38)

Cognition involves objects (including human beings themselves) that we human beings bring forth in language. Maturana notes that human relationships do not involve intersubjectivity but interobjectivity. Simmt and Davis (forthcoming) note that in human conversations we observe ideas bumping together and not bodies, as people might think.

What all this means from the above discussion is that the relationship between knowledge and its teaching and learning in human beings cannot be thought as that of passing information from one human being to another. Rather "knowledge is a structural dynamics" (Felman, 1987). This way of thinking about knowledge is at the center of both enactivism and psychoanalysis.

In mathematics education there is considerable literature exploring mathematics cognition, teaching and learning from enactivist perspective. From this perspective, mathematics cognition is observed as a co-emergent

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[8] Here we should note that, contrary to commonsensical thinking that cognition applies only to human beings, for enactivist perspective, cognition, also applies to nonhuman living things. For Maturana the

phenomenon (Davis, 1997; Gordon-Calvert, 2001; Kieren, 1995; Simmt, 2000). Kieren (1995) notes that teaching mathematics might be thought as "teaching-in-the middle" where the teacher and the students bring forth together the world of significance. My work extends the work that has been done from this enactivist perspective. In particular, I explore the relation between teacher and student in pedagogical relation by considering Maturana's contribution of the function of emotions in a human relation and Davis's contribution of teacher hermeneutic listening (Davis, 1997). For the rest of this chapter I discuss the ways in which we might begin to think about content–pedagogy knowledge in a pedagogical relation.

Content-Pedagogy Knowledge: Knowledge and Ignorance

I begin this discussion by presenting my conversation with the student teacher in the narrative at the beginning of this chapter. The student teacher explained to me how he came to figure out how to teach quadratic equations.

> At first I decided to observe Mr. Jabili, who has many years of teaching experience when he was teaching the same topic. I observed carefully the way he was explaining the steps of solving a quadratic equation. Then I went back and read the textbook again. It was then I realized that the book describes very well how to solve the quadratic equation. I noticed that there are several methods such as, using the general equation, sum-product or splitting the middle, completing the square etc. Lately I have figured out what I need to do in order to teach mathematics: I just ask myself, how do I express myself to someone who does not know what I am talking about. I think a good teacher is one who can express herself very well to her students, who can make them understand what they did not know. (Student teacher narrative)

Reading this narrative we can imagine how this student teaches mathematics. Clearly it falls under what is known as the traditional way of teaching. Kieren (1995) explains this way of teaching as one that falls under rubric TIRE:

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difference between human beings and nonhuman living things is that human beings operate in language.

> The teacher carefully and clearly <u>tells</u> students about some mathematics. The teacher <u>interrogates</u> or questions individual students about the telling. The students give <u>responses</u> to this question. The teacher <u>evaluates</u> the students' responses against a pre-given criterion or against a set of possible responses. (p. 9)

It is a commonplace now in mathematics education to criticize this traditional model of teaching. Reform movements such as that envisioned in the NCTM Standards (NCTM, 1991) suggest ways of teaching different from this model. Yet as I have discussed in Chapter 3, it is also common to find studies that report on how teachers continue to teach in the same way despite these reforms. How then are we to read this resistance of teachers to change?

As I have mentioned, the clue to this question is already given by Maturana's contribution of the relationship between rationality and emotions. That is to say, as human beings our decisions to act are based on our emotions and not rationality.

In order to appreciate this relationship of emotions and teacher's actions, we evoke the notion of the Real, fantasy and *objet petit a* in a Lacanian sense. We recall that the teacher-students relationship might be understood as the relationship between the subject (teacher) and Other (students). Also, that the teacher relates to the students by way of *objet petit a*, the object, the teacher thinks she is to the students. The student teacher in the narrative takes the Other, the students, as those who do not know: "I just ask myself, how do I express myself to someone who does not know what I am talking about." We might say that the student teacher takes the Other (students) as ignorant. This way we can say that the teacher desires *jouissance* of the Other as ignorant. He desires to be 'knowledge' to the students who are ignorant. Here knowledge functions as *objet petit a*. But as I have discussed in Chapter 2, *jouissance* is prohibited, and *objet petit a,* emerges as the lost object, as surplus enjoyment, or pleasure in pain. The student teacher cannot be 'knowledge' to the students therefore he works hard, carefully, clearly, expresses himself well to be this object, 'knowledge'. It is interesting to note that in our continued conversation,

this student teacher told me how he knew many questions from about five years past exam papers. So that when a student would ask any question from these papers he would solve it right then.

We can also approach this discussion by way of fantasy. Recall that in order for fantasy to be operative it must be repressed or unknown to the student teacher. In other words, fantasy is transgressive. In so far as the 'knowledge' functions as the *objet petit a,* for this student teacher, fantasy, which sustains this desire for knowledge is related to ignorance. That is, why the teacher has to express himself very well. The mathematics educator Mary Boole describes this pedagogical relation succinctly:

> The teacher … has desire to make those under [her] conform themselves to [her] ideals. Nations could not be built up, nor children preserved from ruin, if some such desire did not exist and exert itself in some degree. But it has its gamut of lusts, very similar to those run down by other faculties. First, the teacher wants to regulate the actions, conduct and thought of other people in a way that does no obvious harm but is quite in excess both of normal rights and practical necessity. Next [she] wants to proselytise, convince, control, to arrest the spontaneous action of other minds, to an extent which ultimately defeats its own ends by making the pupils too feeble and automatic to carry on [her] teaching into the future with any vigour. Lastly, [she] acquires a sheer automatic lust for telling people to 'don't', for arresting spontaneous action in others in a way, which destroys their power even to learn at the time what [she] is trying to teach them. What is wanted is that we should … not go on fogging ourselves with any such foolish notion as that sex-passion is a lust of the flesh and teacher-lust a thing in itself pure and good, which may be legitimately indulged in to the uttermost.

Few teachers now are so conceited as not to know that they have a great deal to learn, and that their methods need revising and improving, but the majority are seeking for improved methods of doing more of what they are already doing a great deal too much of. The improvement, which

they most need is to… see their conduct, their aims, their whole attitude towards pupils … in the light reflected on them from those of the drunkard and the debauchee. (Boole, 1972, p. 11)

How then are we to seek this 'improvement' as Mary Boole suggests? Or better yet how are we to expand our sphere of possibilities? From what I have discussed above, an obvious possibility is to reverse the notion of the students as ignorant and take them as knowers. What happens if we take student as knowers in a pedagogical relation?

Content-Pedagogy Knowledge: Students as Knowers

This way of looking at content-pedagogy knowledge is already articulated in constructivism. To appreciate more let us read the following student narrative.

> My grade 7 classes are exactly like Ann's Math 13 and 23 classes. They just have a stubborn attitude when it comes to being told to "sit still and work". I too have found that they, and perhaps esp. them, simply can't do that. Perhaps what made the day a bit pleasanter compared to yesterday was that I got them even more involved.
>
> Yesterday I played "bio-jeopardy" with them in science (see the connection?), and they drove me wild with their wild excitement and exteme competitiveness. So today I tried to focus more on the classroom management aspect. But the same grade 7 class gave me trouble as soon as they stepped into the classroom. I tried to "persuade" them to sit down, whatever that means. Not surprisingly that didn't work very well.
>
> So I seized the moment and mustered them out into the hallway. Since I was going to cover the topic on "ordering integers", I had them order themselves first from shortest to tallest. That took them about 5 minutes, to my amusement. Then I threatened to keep them in detention should they fail to beat that time. I jokingly asked them to line up according to I.Q. level, and that miraculously took only 3 minutes. Apparently there was a consensus among the students as to who was the smartest, although I did try a little philosophizing, arguing that they tuned me out. AGAIN. We did this drill a couple more times. A couple of them

questioned the whole point of the "exercise", apparently because they have never done this kind of thing before.

> When I asked them what they thought the whole point of the exercise was, many of them gave me answers that were nice thoughts, such as "to show us how we're so uncooperative with me (the teacher) and with each other", which was absolutely true, of course. But they failed to see the math part until I gave them a hint. But in the end, I think I managed to show them that math doesn't have to be boring. I certainly didn't please all of them with what I did, but I'd like to think that I did please SOME of them at least. (Student teacher narrative)

This student teacher narrative provides us with a pedagogical space to understand what is at stake when the Other (students) is taken as knower, the one who knows. In fact if we read it closely we see that the student teacher changed the pedagogical relation from that we have discussed above, that is taking the Other as ignorant to taking the Other as the knower. Earlier the student teacher had management problems with students. Then he decides to change the relation with the Other (see paragraph three). He takes the students out and has them do an exercise that might lead them to learn mathematics that is, ordering integers. Do we not see here the logic of taking the Other (students) as the knower? What is interesting in this narrative is that which is narrated by the student teacher in the last paragraph. To the student teacher's surprise, when he asks the students the point of the exercise, the students "fail to see" the math until he gives them a hint. Herein lies an impasse in this logic of taking the Other as the knower. An impasse manifested in the form of relation between knowledge and decision. Even though students are taken to be knowers the teacher is the one who decides this.

We should not be tempted to take this experience as unique to the student teacher. Do we not see this logic in constructivist programs, where students are assumed to construct knowledge from their experiences, and yet it is the teacher who ultimately decides whether or which knowledge from students' experiences is mathematics.

How then are we to move out of the impasse? It is here that, I would like to suggest another way of thinking about content-pedagogy knowledge. We could think about it in Hegel's dialectics of negation of negation. If we take the

second way as the negation of the first, then this third way will be the negation of the second. This does not mean that we return to the first but we end up with the new way. I suggest that we take ignorance to the subject (teacher) himself. Put differently, this way of understanding content-pedagogy knowledge might be thought as the teacher in the first way, identifying or traversing his or her fantasy. I call this way pedagogical ignorance.

Content-Pedagogy Knowledge: Pedagogical Ignorance

Before I discuss what this way of understanding content-pedagogy knowledge might mean for the teaching of mathematics lets take a detour through the work of Lacan again and consider what he has to say about knowledge in his seminar *Encore*. In this seminar Lacan (1998) notes that: "the status of knowledge implies as such that there already is knowledge, that is in the Other, and that it is to be acquired. That is why it is related to learning" (p. 96). Lacan's notion of knowledge in *Encore* marks a shift from his early teaching, in which he was concerned with the inauthentic objectifying knowledge that disregards the subject's position of enunciation. He argues, instead, for the (other) knowledge that is at the centre of the subject's subjective truth. This knowledge involves no inherent relation to truth and no subjective position of enunciation, not because it dissimulates the subjective position of enunciation but because it is itself non-subjectivised. This knowledge belongs to the Lacanian Real.

This knowledge in the Real involves the form of knowledge of the subject's "fundamental fantasy". In the Lacanian sense the function of fantasy is: to prescribe and limit specific possibilities of enjoyment (the conditions of the object); to figure and conceal the self division and the subjection to the desire of the Other; to both materialize and resist the constitutive impossibility of the social relationships (the radical disjunction and asymmetry between the subject and object). In order for fantasy to be operative, it must be repressed (unknown). It follows that knowledge (of fantasy) can only be re-constructed. In psychoanalysis, this involves the process of construction. Construction might be

thought as a purely logical explanatory presupposition of fantasy. If we look closely at this notion of fantasy and its construction we might see that knowledge and ignorance must somehow be related. In fact, in so far as this knowledge is in the Real, then the relationship of knowledge and ignorance might be thought as that of complementarity as discussed in Chapter 2. In other words, the relationship between knowledge and ignorance might be understood by the logic of the two sides of a mobius band. If we follow knowledge to its limit we encounter ignorance. In this way ignorance might be thought as the limit of knowledge. Ignorance is not lack of knowledge but 'resistance to know' (Felman, 1987). It is from this paradoxical relationship of knowledge and ignorance that pedagogical ignorance must be understood.

In order to appreciate more this notion of pedagogical ignorance I use the work of Mary Boole (Boole, 1972). Even though it was written before 1916, this work provides us with some orientation for understanding pedagogical ignorance. First Mary Boole provides us with some initial thoughts when she talks about the origin of algebra:

> ...the origins of algebra lie in acknowledging ignorance of the answer to the problem. Knowing you do not know enables you to denote what you do not know by some symbol, and then to treat it as if it were known in order to write down expressions or properties, eventually arriving at knowledge of what previously you were ignorant. (Mason & Spence, 1999, p. 147)

Do we not see in this logic of algebra in the notion of construction of knowledge involving fantasy as mentioned above? Let us follow this logic by considering the pedagogical relation keeping in mind the functions of fantasy as mentioned above. We recall that, the relationship between the teacher and students cannot be thought in terms of complementarity and harmony. The teacher relates to the students through the *objet petit a*, the object of fantasy. What this means is that as a teacher, my student(s) remain the Other, I cannot 'know' them. Therefore in my teaching, I must include my ignorance of my students and denote by some 'symbol' and then treat it as if it were known, in order to act. Of course, the

Lacanian name for this symbol is the master signifier. We recall that the signifier in itself does not mean anything. Its function is to represent the subject for another signifier. The master signifier promises meaning and withholds it so that it engages the teacher in her teaching.

Let us now move on to discuss the function of pedagogical ignorance in the teaching of a subject, keeping in mind, again, the functions of fantasy. Here we are dealing with the function of fantasy in prescribing and limiting specific possibilities of enjoyment (the conditions of the object) as well as figuring and concealing the self-division and the subjection to the desire of the Other. Let us begin with the conditions of the object (of knowledge). Here Maturana's notion of objectivity in parenthesis provides us with a direction:

> As we put objectivity in parenthesis because we recognise that we cannot experientially distinguish between what we socially call perception and illusion, we accept that existence is specified by an operation of distinction: nothing pre-exists its distinction. In this sense houses, persons, atoms, or elementary particles, are not different. (Maturana, 1988b, p. 39)

What this means is that reality, what we experience as objective, as a result of operating in language as human beings, includes illusions, fictions and perceptions. We have no way of distinguishing what is illusion, fiction or perception.

In a Lacanian sense, reality is a result of fantasy. It is fantasy that provides a frame for us to experience our reality as coherent and consistent. Again this fantasy that sustains our reality has to be repressed. It follows that we cannot stand at a neutral place and distinguish illusion, fiction or perception from our reality. Therein lies the paradox of knowledge and ignorance: what we know in reality is based on our ignorance (of fantasy; not being able to distinguish illusion and perception).

As Maturana notes, there is no difference between house, atom and we can add, the so-called mathematics objects or concepts. As human beings operating in language, "of nothing therefore, that has place, or passes in our

mind, can we speak or so much as think, otherwise in the way of fiction"
(Bentham, quoted in Zizek, 1993, p. 88).

How then might we think of pedagogical ignorance in the teaching of a
subject? The discussion above, throws a question about the teacher's relation to
knowledge of her teaching subject. Put differently what does it mean to graduate
as a mathematics teacher? What does that mean by this in a pedagogical
relation? Mary Boole gives us some direction:

> Mathematical certainty depends not on the subject matter of investigation
> but upon three conditions. The first is a constant recognition of the limits of
> our own knowledge and fact of our own ignorance. The second is
> reverence for the As-Yet-Unknown. The third is absolute fearlessness in
> meeting the *reductio ad absurdum*. In mathematics we are always
> delighted when we come to any such conclusions as 2 + 3 = 7. We feel
> that we have absolutely cleared out of the way one among the several
> possible hypotheses, and are ready to try another. (Boole, 1972, p. 44)

Even though Mary Boole speaks about mathematics, I suggest that the first and
the second conditions apply to any subject. That is to say the function of
pedagogical ignorance in the teaching of a subject might mean the following: the
teacher recognises the limits of her knowledge and her own ignorance (of
fantasy); the teacher respects the 'as-yet-unknown'. This is actually what is at the
heart of cognition for autopoietic system as I discussed in Chapter 2: the bringing
forth of signification that is missing, not pre-given. Put differently teaching a
subject is setting conditions for the teacher and students to bring forth the world
of significance. And we might add here that since as human beings we operate in
language, bringing forth this world of significance is producing master signifiers.

Teaching, thus involves including ignorance in our actions. We cannot
'know' our students. Students remain the Other to the teacher. We must include
our ignorance and denote an x, a signifier that engages us in our teaching. Also
we relate to our students through the *objet petit a*, 'what is more in us'. Thus what
I perceive as problems or inconsistencies in my students are 'what is more in
me'. Therein lies the ultimate ethical nature of teaching.

Teaching a particular subject involves taking the limits of our knowledge of subject matter, i.e. taking our ignorance into account so as to let our students produce new signifiers. "Teaching is to let others learn, that is to bring one another to learning" (Heidegger, 1977, p.275).

Chapter 6

RE-ASSEMBLING MY PRACTICE

As I draw this piece of writing to a conclusion, it seems apt to refer once again Mary Boole's work:

> It seems to me that most discussions about Education are vitiated by one great flaw; Educationalists seldom recognize the proper inter-play of the two actions. They know that the child must be taught to see clearly the difference between some things; and they know that he must be taught to see the Unity between some other things; but they do not, in fact they dare not, realize that the process of sound thinking consists, emphatically, in seeing Unity where one has already perceived contrast. It is simply a farce – now that we know the law of man's reasoning organ – to dignify anything with the name of Education which does not provide constant opportunities for the human reason to say "x plus not-x form a Unity": and that about some x which the mere human perception has seen sharply contrasted with the not-x. (Boole, 1972, p. 23)

As I was pondering the title of this chapter, I wondered whether or not assembling was the right word choice. In some ways I felt that maybe disassembling would be more befitting for the title. Nevertheless, as I re-read the words of Mary Boole, I realized that I did not need to languish deep in that wondering because assembling and disassembling must be two words 'minted' on the same coin, albeit on the opposite sides. Because I framed this research as a questioning of my own practice, I oriented my study as an action research. As a practical enquiry, action research is concerned with understanding practice. In addition, it is concerned with social change. While this study is not about action research, it delineates some important issues that might inform action research. My experience of doing this research might contribute to action research, by showing the effects of doing action research on the learning as well as the dynamics of identifications of the researcher. That is to say, the study

might show the ongoing interplay of theory and the reading and interpretation of student teachers' narratives and the learning transformations that I experienced. In short, action research is a living practice of teacher education.

But this is just one of the reasons for writing this chapter. Another reason, perhaps the more important one, is to tell the story of my journey, for how can one count to have arrived (or, at least gone far) if she or he cannot remember where she or he had come from? In this way, I believe I am being responsible to my readers: by explaining what I have learned from this research experience.

I begin by presenting my experience in doing a study like this in teacher education. In the next section, I explain the approach I have chosen to use in my research that is, the interplay between epistemological obstacle and ontological limitation. Then I report on what I have learned from the student teachers. This is followed by section in which I attempt to explain what we might begin to understand about knowledge in teacher education. Finally I discuss the implication of all this for teacher education.

Researching Practice

In seminar XI, Lacan (1977) defines a praxis as a "concerted human action, which places man in a position to treat the Real by symbolic" (p.6). Maturana (1988a, 1988b) notes that in so far as we are human beings we operate in language. We find ourselves in this experience in language as such. This means that what we can do is to explain our experience. Thus, researching one's practice implies treating the Real by the symbolic (symbolizing the Real) or explaining one's experience. Since I have already explained my experience of this research, in this section I present some of the experiences that I feel might be important for anybody doing this kind of research.

One of the things I have learned from doing this study is that it involves the dynamics of identifications (symbolic and imaginary). My imaginary identification might be thought of as my identification with the question. In order for this to be meaningful to me, I had to read the literature in teacher education.

This might be thought of or taken as my symbolic identification. Teacher education is a very complex field. As I started reading the literature I found that it was awash with so many issues - issues such as pre-service and in-service teacher education, the structure of the programs (coursework and field work), teacher's knowledge, teachers' beliefs and conceptions. Consequently, in some respects, my symbolic identification was not an easy task, as my first chapter attests. Because I was concerned with the teachers' knowledge of teaching a particular subject, mathematics, I centered my research on the question of knowledge in teacher education, specifically the question of pedagogical content knowledge. Therefore pedagogical content knowledge might be considered as my master signifier. As a master signifier, in itself does not mean anything, pedagogical content knowledge, allowed me to engage in the research, and finally being able to produce a new signifier, that is, content-pedagogy knowledge.

Epistemological vs. Ontological

The interplay between the epistemological obstacle and ontological limitation is a turning point in my experience in this research. In psychoanalytic language this might be thought of as reconfiguring of my fantasy as opposed to symbolic re-articulations. In the enactivist perspective this might mean an "organizational change" as opposed to "structural change". I started with the question arising from my dissatisfaction of applying constructivism in my teaching. My search was for an alternative way of understanding the knowledge of teaching of mathematics and teacher education. The combination of enactivist theory and psychoanalytic theory provided me with this alternative. These theories allowed me to situate my original problem as an epistemological obstacle, in my search for a better way of understanding knowledge of teaching mathematics. In other words, I was looking at it through the glasses of "problem solving". With this kind of mentality, I reduced the whole issue to a kind of "Here is a problem that I have to solve".

Later in my research, drawing on enactivist and psychoanalytic perspectives, I learned that what seems to be a problem, that is, an epistemological obstacle, was a limitation that actually reflects ontological difficulty (ontology understood in psychoanalytic sense: neither being nor non-being). This approach allowed me to read the proliferation of perspectives on the nature of pedagogical content knowledge as not reflecting an epistemological obstacle, rather the response to the non-symbolizable Real. That is to say the method allowed me to see these different responses as reflecting the 'gap' or 'hole' in the field of meaning, the symbolic order.

So, instead of searching for a better orientation to pedagogical content knowledge, I had to revisit constructivism, informed with enactivism and psychoanalysis, to learn what was the ontological limitation in the object of knowledge in constructivism, that is, the individual. Borrowing from Boole's analogy, if we take the traditional view of teaching mathematics as x and constructivism that challenges this view as not-x, then enactivism and psychoanalysis provides a unity of the traditional view and constructivism. These perspectives made space for me to accomplish this by elucidating the apparent difference or contradiction between the traditional view and the constructivist view as a reflection of the limitation of our reality itself and our subjectivity. In a similar vein, the two main perspectives on knowledge in teacher education, for and against Cartesian subjectivity, were taken to reflect our reality and our subjectivity.

In enactivist and psychoanalytic terminology, this turning point is attributed to my change of focus and understanding of the function of the Real (in psychoanalysis) and the function of organization in an autopoiesis of living things (in enactivism). This interplay between the epistemological and ontological has influenced the kind of the literature review in this study. Instead of reviewing studies related to various perspectives on pedagogical content knowledge – for example, social constructivism and situated cognition, I concentrated on constructivism for the reason that, in my view, the problem in constructivism is ontological rather than epistemological. Viewing the problem as an

epistemological obstacle results in an incessant proliferation of perspectives, each of which, change the object of the knowledge: from individual to social, culture, context and so on. However, these seemingly varied perspectives are either a continuation of constructivism or a critique of a particular strand of constructivism – but on the whole they still fall under the not-x category.

Learning to Teach: Student Teaching

There are two ways of researching or reading student teachers' experiences. In psychoanalysis these might be taken as symptomatic reading and the reading of the fantasy. The symptomatic reading is what Jardine (1998) calls the pathological/curative reading. In psychoanalysis the methods used in reading these experiences are different; whereas symptomatic reading involves interpretation, reading fantasy involves the process of construction. This is because, as I have mentioned, knowledge of fantasy cannot be subjectivised and therefore cannot be interpreted. The goals for these approaches are also different. Symptomatic reading aims at finding the problems so as to intervene and solve them. Thus in the context of this study, it looks for pathological problems with student teachers in order to find a cure. On the other hand, reading fantasy involves some kind of unknowableness or otherness, which is a different kind of goal. As a result, reading fantasy or constructing knowledge of fantasy ultimately involves learning a number of things about ourselves and our practice from student teachers.

I have attempted to use the method of construction or reading fantasy to understand our practice. For this reason, the reading of Chapter Four ought to leave one with a question regarding our practice, rather than just something about the student teachers. Knowledge involving fantasy is the knowledge in the Real.

We come across the Real as that which "always returns to its place" when we identify with the Real in the Other - that is to say: when we recognize in the deadlock, hindrance that which is "in us more than ourselves." (Zizek,

1991, p.102)

In enactivism this is the knowledge that involves our 'organization'; it is that which defines our class identity—as teachers. This knowledge is at the center of the cognitive act. Learning about this knowledge means learning about our collective identity.

Knowledge in Teacher Education

"Knowledge is an enigma" so begins Lacan (1998, p. 125) in one of the chapters of his seminar *Encore*. Nowhere else in our experiences than in teacher education is this statement truer. In teacher education, we have attempted to get through this enigma in many ways; as well, we have given it numerous labels: narrative, contextual, personal, subjective, objective, tacit; pedagogical content knowledge, pedagogy knowledge, curriculum knowledge, knowledge of the learner, and so on. In addition to that, we have come to ponder the nature of knowledge of our subject areas such as mathematics, science, art, and social studies.

My approach is geared towards allowing us to comprehend these different ways of understanding knowledge as a reflection of what we call reality itself and our subjectivity in language. From Maturana's notion of 'objectivity in parenthesis' we learn that our inability to distinguish between what is illusory from what is perceptive is constitutive of our existence as beings in language.

We also learn from psychoanalysis that what we call reality is based on the disavowal of our fundamental fantasy. From this, we learn that our knowledge is based on ignorance. Hence, ignorance is not lack of knowledge but the limit of knowledge. As teachers then we must learn to include our ignorance in our relation with our students. The next section offers the implications of this in teacher education.

Implications for Teacher Education

What then are the implications of my study for teacher education? Once again, Felman (1987) provides us with a starting point: "As a question in which practice, rather than theory, is at stake, the unconscious, in Lacan's view, is grounded not so much in an ontological as in ethical experience" (Felman, 1987, p. 69). That is to say, the implications of my study for teacher education are grounded in an ethical experience.

The question of ethics in social practices is not limited to Lacan's view. Zizek (1997) notes three options of philosophical approach to ethics. First, that which attempts to ground ethics on some substantial notion of supreme Good. Second, that which challenges the substantial and the universalism of the first and giving its universalism a proceduralist twist and third, the postmodern option which urges us to be aware of the fictitious nature of truth and therefore not to impose our rules to the rules of the others. Zizek further notes that, despite their challenge to the substantial and universalism of the first option, the second and third options continue to function in the same way, that is they continue to privilege a certain positive content. For example the postmodern option continues to impose some rules albeit at a second-level, rules such as those of tolerance, rules of accepting the irreducible difference and so on.

> It is Lacan's position in relation to this triad, however, which enables us to break out of it by articulating a fourth position: an ethics grounded in reference to the traumatic Real which resists symbolization, the Real which is experienced in the encounter with the abyss of the Other's desire (the famous 'Che vuoi?', What do you want [from me]?) (Zizek, 1997, p. 213-14)

As I have mentioned in Chapter 2 and elsewhere in this dissertation, the Lacanian Real is the overlap of two lacks (lack in the subject and the lack in the Other). It follows from this Lacanian position, that ethics cannot be grounded on any ontology. "At its most elementary, ethics designates fidelity to this crack

[overlap of two lacks]" (Zizek, 1997, p. 214). In what ways then are we to articulate this fidelity to Real, which is fidelity to "gap" in teacher education?

Before we answer this question it is important that we note the difference between the Real and what we call the reality of our experience. The Real is "that which, precisely, prevents us from assuming a neutral-objective view of reality, a stain which blurs our clear perception of it" (Zizek, 1997, p. 215). Put differently, from Maturanian position, fidelity to the Real is fidelity to 'objectivity in parenthesis'. It is fidelity to the fact that as human beings in language we cannot distinguish illusion from perception of our reality. In addition to this, the Real is that which is non-symbolyzable, it is the limit of our signification, of our language, of our field of meaning. This however does not mean that the Real is outside the field of meaning or the 'beyond' that we strive to capture through our symbolization or signification. The real is inherent to symbolic order; it is its internal limit. "The consistency of our language, of our field of meaning, on which we rely on our everyday life, is always a precarious, contingent *bricolage* that can, any given moment explode into lawless series of singularities" (Zizek, 1991, p.154). This "explosion", the inconsistency of the symbolic order is precisely the intrusion of the Real.

In Chapter 4 I have attempted to show how we might begin to talk about this inconsistency of the symbolic order when it is penetrated by the Real of *jouissance* in teacher education. I have done this by showing how we might read student teachers' narratives of their learning to teach experiences precisely as their encounter with the desire of the Other epitomised by students. In other words, I have attempted to show how we might read their narratives as their question of identity, that is, "what does the Other want from me?" In what ways then the ethics of the Real or fidelity to this Real might mean in this context of student teachers learning to teach for teacher education?

Let us first discuss what might be the possible responses to this encounter with the Real, when suddenly things don't mean anything at all. Let us recall the example of a student teacher in Chapter 4 who is confronted by bright students who do not see the importance of her repeating of examples in the class. Zizek

(1991) using Wittgenstein, discusses three modes of answers to such an experience. First the student teacher might behave "rationally" and replace her previous certainty with doubt. ("Maybe students behave this way.") Second, the student teacher might be shocked and her capacity to think and judge undermined. ("If students behave this way then teaching is very complicated.") Finally, the student teacher might refuse this experience and stick to her previous certainty. ("All what these students are saying is nonsense, the reality (teaching mathematics) is that I have to teach this way.")

These responses allow us to see the ethical dimension of fidelity to the Real. Because the point is not just to show or describe the truth of the Real by showing how we experience it as in the above responses. But rather to show how this inconsistency of the Other has its reverse in the splitting of the subject. That is, in the subject's division into the signifier (teacher in the case of the student teacher) that represents it in the symbolic order and its counterpart object, *(objet petit a)*. What this means is that "we must confront the way we ourselves by means of our subjective position of enunciation are always already involved, engaged in it" (Zizek, 1997, p. 215). This implies that, we must confront the way we ourselves are already engaged by means of our fundamental fantasy. What then does this mean for teacher education?

As I have mentioned elsewhere in this dissertation, in order for fantasy, (that which constitutes a frame by which we experience our reality as consistency) to be operative it has to be inaccessible to the subject's experience. Fantasy as Zizek (1997) would put, "belongs to the 'bizarre category of the objectively subjective – the way things actually, objectively seem to you even if they don't seem that way to you'" (p. 119). Fantasy involves knowledge that is "desubjectivized". Here again, the mathematics educator, Mary Boole provides us with a guide of what to do with fantasy in teacher education. In her discussion on what she calls a "centre of gravity" of a student, which is a region where apparently conflicting passions mutually overlap (notice the close relationship of this centre of gravity to the Lacanian Real), she gives the following guidance to teachers and parents on what to do with child's centre of gravity:

> In this matter, as in many others, the fact which is most important for us to know is that of our own ignorance. We cannot know what is the centre of gravity of a young nature; let us then not act as if we knew. We know only that it lies at the meeting point of the character's extremes. (Boole, 1972, p. 20)

That is to say in dealing with fantasy, which means our fidelity to the Real, we must include our own ignorance (which is our fantasy). We cannot know what is the fantasy of our students or student teachers. As I have discussed in Chapter 4 and Chapter 5 fantasy cannot be interpreted. Fantasy which, involves the knowledge in the Real just 'shows' in the inconsistencies in our symbolic order. It shows in those split utterances such as "I know, but nevertheless…" (Zizek, 241). Examples of these abound in teacher education, "I know that students need to be left to learn by themselves nevertheless I am teaching this way because they have to do the public exam". Here we should not fall into a trap of pointing these occurrences as student teacher's fantasies. For we are also already included in them at the level of our own fantasy. Here Jardine (1998) provides us with a direction. With respect to the teacher's or student teacher's encounter with the "monstrous child" Jardine alludes:

> The monstrous child thus faces me with my own ability (or lack of ability) to remain open to the new, to face my own renewal: am I able, as a teacher, to listen anew to this child and let that what I take to be established be reenlivened and made new through their questions? (p. 132)

Likewise as teacher educators we must face these teachers' (student teachers') split utterances, for example as our own renewal, as places where our knowledge resists (Carson, 1997) and calls for starting anew again.

What then does this mean to mathematics teacher education? To get us through this, once again, I refer to Mary Boole's work. In a certain case Boole (1972) responds to the concern that has been raised by a Professor: "students of engineering and electricity cannot use their mathematical knowledge to facilitate their study of real forces to anything like the extent which they would do if their

knowledge of so much arithmetic or other mathematics as they have learned were real and vital" (p. 20). Boole argues that, this concern raises a question in mathematics education that "What are the conditions which favour a vital knowledge of mathematics?" (p. 20). To answer this question, Boole contends that: "It may surprise some readers to be told that those conditions are almost entirely moral and spiritual rather than intellectual" (p.20).

What is of interest to me here is the fact that even though Mary Boole was writing this between the years she lived 1832 –1916, the question and concern discussed above are still alive in mathematics education. The literature in mathematics teacher education is full of ideas, theories, on how to teach mathematics meaningfully. Many such ideas are reflected in documents such as the Curriculum and Evaluation Standard and Professional Standards for Teaching (NCTM, 1989, 1991). Implicit in these ideas is the notion that we should de-emphasise the rote teaching of skills and routines in mathematics and emphasise the meaningful teaching of mathematics concepts and skills. As I have discussed in Chapter 3, despite these ideas, the rote teaching of mathematics skills still persists in many classrooms.

Perhaps mathematics teacher educators should rethink Boole's idea that the conditions for meaningful learning and teaching of mathematics are moral and not intellectual. In my case what this means is to rethink mathematics teacher education in ways that I have discussed above. That is to say to rethink the practice of teaching mathematics as an ethical experience. To rethink mathematics teaching in terms of an ethics that is based on our fidelity to the Real (in Lacanian sense) or objectivity in parenthesis (in Maturanian sense). An immediate implication that I see arising from this ethics is that it does not make any sense to debate about the role of skills and routines as opposed to the meaningful teaching of mathematics anymore. As Boole argues:

> Education means the educing of faculty. Children need many things besides education; many things which can best be given- some of them can only be given- under a regime of orderly routine. Among these good things are discipline and training. But it would be well to remember that,

during the time that these other good things are going on, education itself is not going on. Education proper is given by rare and episodical occurrences, which give to those dormant faculties which disciplinary routine is holding down and keeping quiet opportunity and stimulus to start into active life. (Boole, 1972, p. 16)

And what are those episodical occurrences, Boole is alluding here, if not the occurrences of inconsistencies of our symbolic order, of our field of meaning when it is penetrated by the Real.

Davis (1996, 1997) comes close to what I am suggesting here in mathematics teacher education when he offers listening as way of thinking mathematics teaching. He discusses several forms of listening including; listening for (where the teacher looks for match between the pre-given response he or she has in mind and the student's response; listening to (where a teacher tries to characterise the student's mathematics actions and utterances); and listening with the other or hermeneutic listening (where listening involves interaction among speakers and listeners such that the speaker's answer is an explanation in which meaning is made by both speaker and listener). Here I suggest that in we add the fourth form of listening, which I call non-hermeneutical phenomenological listening, following Zizek's discussion of how the Real shows itself in our experiences:

Phenomenology is now reasserted as the description of the ways in which the Real shows itself in phantasmic formations, without being signified in them: it is the description, not interpretation, of the spectral domain of mirages, of 'negative magnitudes' which positivize the lack in the symbolic order. We are thus dealing here with the paradoxical disjunction between phenomenology and hermeneutics: Lacan opens up the possibility of a radically non-hermeneutical phenomenology of descriptions of spectral apparitions which stand in for constitutive non sense (Zizek, 1997, p. 218).

Just as I have discussed above, it is this non-hermeneutical phenomenological listening in which not only that students learn but also teacher learns. He or she learns anew. It is also in this same way that I suggest mathematics teacher

educators begin to rethink our practice. The student teachers in my study were all math majors teaching mathematics. In this sense my discussions in Chapter 4 might show what this rethinking might be. What is more is that, perhaps we must begin to listen in a non-hermeneutical phenomenological sense when our student teachers say for example "I know using manipulatives to teach mathematics meaningfully is important nevertheless I don't think I will use them in my teaching". In this way we might begin to rethink our own knowledge, in terms of what Mason alludes as "researching from the inside" (Mason, 1994).

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